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To Buy, Borrow or Beg?

WHEN funds and circumstances allowed, it was pre-war Air Ministry policy to buy specimens of such foreign aircraft as seemed to merit evaluation. Mostly the purchases never came to public notice, and we should imagine that their extent will surprise all but a handful of readers. From America we acquired a Vought Corsair and a Northrop 2E; from France a Breguet XIX and a Dewoitine D.500 (with *moteur canon*); from Germany a Dornier Delphin III and Komet, a single-engined Junkers and a Heinkel He64; from Belgium an Avions Fairey Féroce; and from Holland a pair of large Fokkers. Private companies also were in the market for specimen aircraft of exceptional quality, or having out-of-the-ordinary characteristics, and the best-known of such purchases was Rolls-Royce's Heinkel He70, which enabled advanced liquid-cooled engines to be developed at really high speeds. Bristol adapted the Northrop for similar duties in respect of their big air-cooled radials.

Such acquisitions were shrewd investments; and while it is clear today that current examples of foreign Service aircraft, with their all-important equipment, may often be denied us on security grounds (if not by our own finances), it is equally obvious that mutual profit would accrue if foreign airframes could be borrowed or bought for the flight-testing of British powerplants. The hard facts are that, until the SR.53 is flown, we shall have no supersonic vehicle for our advanced rocket units; nor will it be possible, for months or years to come, to assess the behaviour of the Gyron, Olympus or Conway under level-flight conditions beyond Mach 1. It seems reasonable to suggest that the Americans, having lent Canada a B-47 for testing the Iroquois, might spare us in Great Britain a supersonic aeroplane or two from their now-abundant stock.

Can it be that the two nations which jointly produced the Liberty/D.H., the Merlin/Mustang, the Whittle/P-59 and the Goblin and Nene/P-80 have so quickly forgotten that mutual aid can often be turned to mutual profit? Or is it that our Ministry of Supply is content that Britain's peerless supersonic powerplants shall continue to remain subsonic?

Give and Take

Outside the few restrictions imposed by certain aspects of national or commercial security the co-operation between Britain and America seems to be both active and unfettered. On a man-to-man engineer basis, of course, the whole technology of modern aeronautical endeavour is advancing on a broad front on both sides of the Atlantic. It is now better appreciated that the transmission of information is just as much east-to-west as *vice versa*; and this appreciation is most marked at the man-to-man engineer level.

At one period a section of the American public tended to regard us as a nation of beggars and borrowers; and a surprisingly high proportion still seems to believe that this country relies entirely on the U.S.A. for military aircraft and at the same time corners the airline market with transport aircraft financed by dollars given by the American taxpayer for strengthening our defences. What is today's true picture? Of the total number of combat aircraft in British service, rather more than 99½ per cent are entirely indigenous. The exceptions are the Douglas AD-4W Skyraider, one squadron of which are operating as early-warners with the Royal Navy, and the Lockheed P2V-5 Neptune. The latter has been in service with the R.A.F. Coastal Command, but has now been almost completely replaced by the Shackleton.

As for the charge that it is Uncle Sam's generosity that has allowed us to sell Viscounts, Comets and Britannias inside America, we may be sure that these same aeroplanes would still have been developed, built and sold without one cent of American money. Moreover, every iota of Mutual Defence finance for Sea Hawks, Hunters, Valiants and Canberras has been duly accounted for in the form of tangible aircraft; were this not so, the money would simply not be paid.

Fortunately, aircraft engineers of both sides of the Atlantic enjoy each other's mutual respect; and in the long run their achievements are of greater consequence than public misconceptions.

FROM ALL QUARTERS

The B.E.A. Viscount Accident

A PUBLIC INQUIRY has been ordered by the Minister of Transport and Civil Aviation into the accident which occurred on Thursday afternoon, March 14, to B.E.A.'s Viscount 701 G-ALWE, *R.M.A. Discovery*. The aircraft—on flight BE 411 from Amsterdam—struck houses on the approach to Ringway Airport, Manchester. All 15 passengers and the crew of five, and two occupants of the houses, lost their lives.

Forty-eight hours after the accident a joint statement by B.E.A. and Vickers-Armstrongs (Aircraft), Ltd., said:—

"B.E.A. and Vickers, by agreement with the Air Registration Board, have withdrawn a number of B.E.A. Viscount 701s for special investigation of the flap-operating mechanism. . . . This is a purely precautionary measure and it is expected that the Viscount 701 fleet will be back in service in a few days. . . ." A later statement issued on behalf of Vickers said that the company was communicating with other operators of Viscount 700 types "with details of the precautionary inspections deemed necessary on certain Viscounts elsewhere."

Sufficient evidence already appears to have been obtained to enable Vickers and B.E.A. to feel confident that the cause of the accident has been established. Although neither the Corporation nor the manufacturer is able to comment, since the matter is *sub judice* pending the inquiry, two Press reports may be significant. A Sunday newspaper referred to the discovery of a small bolt among the wreckage, and quoted investigators as saying: "We think we have found all the parts we need for our investigation." A further newspaper report on Monday said: "First clue to the cause of the accident was given by an eye-witness who saw part of the starboard flap buckle."

At the time of going to press, ten of B.E.A.'s 701s are back in service, after inspection of some aircraft at London Airport and of others at Vickers' Wisley airfield.

This is the first fatal accident to B.E.A. Viscounts in passenger service since the aircraft was introduced in April 1953. The machine concerned, G-ALWE, was the first production aircraft and the third Viscount to be built (it flew on August 20, 1952). It had completed about 7,000 hours.

Airship Flight Record

A U.S. NAVY Goodyear ZPG-2 airship last week broke the dirigible record for a non-refuelled flight when it secured at Key West, Florida, on March 15 after a flight which had begun at South Weymouth, Mass, on March 4 and lasted 264 hours 14 minutes. The previous record—200 hr 12 min—was established in 1954 (by a ZPG-2), and an unofficial distance record was set up in 1929 by the *Graf Zeppelin* with a flight of 6,384 miles.

The purpose of the flight—during which the dirigible passed over Portugal, the Canary Islands and the west coast of Africa—was described as "testing and evaluating the all-weather capability of airships for use in airborne early-warning and submarine-defence systems."

Filled with helium, the ZPG-2 type is of 975,000 cu ft volume, measures 343ft in overall length, and is powered by two 800 h.p. Wright R-1300-2A Cyclone 7s. Maximum speed is over 85 m.p.h. A crew of 14 is accommodated in the two-deck control car.

New Bristol Engine Ratings

PROOF of the remarkable development potential inherent in Bristol gas-turbine engines is provided by the announcement last week of the successful completion by the Olympus 104 of an official type test at 13,000 lb dry thrust (representing the BOl. 12 rating). In addition to the type test, the Olympus 104 has also completed a bench run to the 150-hr type-test schedule in which both take-off running and cruising running was all carried out at the full rating of 13,000 lb. "This," state Bristol Aero-Engines, "provides a very much more severe proof of engine reliability than the official type test."

The Olympus 104 is the latest member of the basic Olympus 100 series. Earlier members include the 101, of 11,000 lb dry thrust, and the 102 (12,000 lb). Both these are in full production, the Olympus being the standard powerplant of the Avro Vulcan bomber. Mechanically, the Olympus 104 is virtually identical with the 101 and 102, and the latter can be converted to the 13,000-lb rating during normal overhauls. It is rare indeed that an engine can be given a 2,000-lb increase in thrust by such minor modification without any sacrifice in life or reliability. (Later members of the Olympus family, such as the BOl.6, are even more powerful, and have been type-tested at 16,000 lb thrust.)

Two new Orpheus ratings are those of the BOr.4 and 11. The former is a derated Orpheus 3 intended for trainers and small civilian aircraft, and has a conservative rating of 4,230 lb. The reduced rating ensures minimum specific fuel consumption and, by reducing the operating temperature and r.p.m., extends the engine life between overhauls.

While the BOr.4 marks the entry of the Orpheus to training, transport and executive fields, the basic high-thrust Orpheus reaches its latest development stage at the BOr.11 rating of 5,760 lb dry thrust. The military Orpheus is being developed under the Mutual Weapons Development Programme managed jointly by the U.S.A. and the United Kingdom, and is the power unit of the lightweight fighters intended for NATO service. Early this month bench time exceeded 6,200 hr; and flight time in the Folland Gnat, Fiat G-91 and Avro Ashton is in excess of 200 hr.

Third of the Bristol engines to reach a new development stage is the Orion high-efficiency turboprop. The BOn.2 has the same ratings as the BOn.1, namely 5,150 maximum e.h.p. comprising 4,400 s.h.p. and 1,950 lb thrust. It does, however, incorporate a number of mechanical design advances resulting from extensive ground running as a complete powerplant and from flight experience in the Britannia 101. Four Orions will be installed in the Britannia 301 when the latter aircraft becomes available.

SOON TO FLY at Boscombe Down is the Short SC.1 VTOL research aircraft (five Rolls-Royce RB.108 turbojets). In this new photograph the aircraft is seen undergoing taxying trials in the hands of Mr. Tom Brooke-Smith, who will be at the controls on the first flight.

—And Some Others

ALSO promulgated are the following designations and ratings: Rolls-Royce Dart RDa.11 (2,100 s.h.p.); Napier Eland NEl.6 (3,150 s.h.p. and 915 lb thrust); Blackburn Palouste Bn.Pe.3 (258 g.h.p.); Armstrong Siddeley Viper ASV.11 (2,460 lb thrust). The existence is notified of a Rolls-Royce Conway designated R.Co.11.

A new aircraft mark revealed is the Fairey Gannet T.5. Externally it is identical with the earlier T.2, but we are not permitted to describe such internal differences as may exist.

Richard E. Byrd

WE regret to record that Rear-Admiral Richard E. Byrd, distinguished American airman and explorer and the first man to fly over both the North and South Poles, died suddenly at his home in Boston, Mass., on March 11 at the age of 68.

Only last year Byrd made his third flight over the South Pole; and because of his unrivalled experience of Antarctic exploration he had been named overall head of the U.S. Navy's Operation Deep Freeze.

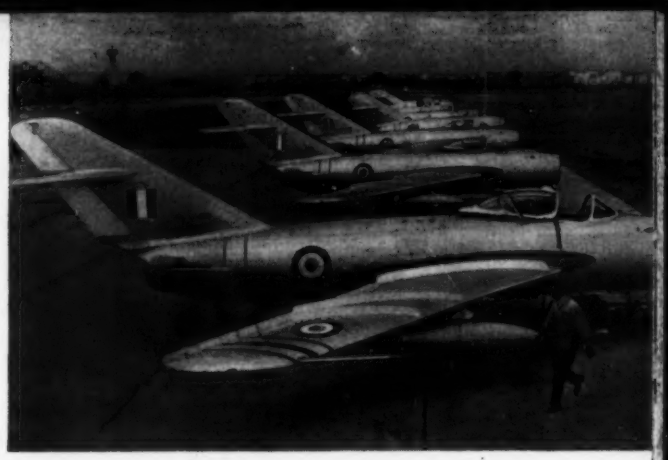
Rear-Admiral Byrd

Throughout its course the career of this Virginian of slender frame and steel-blue eyes was marked by courage and determination in overcoming misfortunes, aided by an occasional dash of good luck such as all brave men deserve.

Thus in 1921 when he was in England as one of the crew which was to fly the R38 back to America, he missed his train so was not aboard the airship when it broke up and caught fire; in 1927 he fractured an arm in a crash, and so was forestalled in his ambition to fly the Atlantic by the flights of Lindbergh and Chamberlain. When he did, during 1927, in a Fokker F.VII/3m with Noville, Acosta and Bernt Balchen, they had to come down in the sea off the French coast, owing to dense fog, and rowed ashore. In 1933 Byrd was left alone in Antarctica for 4½ months, making meteorological studies in a small hut near the Pole. He was poisoned by fumes from an oil stove and fell, again breaking an arm; but by a magnificent gesture had hot soup ready waiting for his rescuers.

Such misfortunes only seemed to stiffen Byrd's determination and his fame as an aerial explorer of the Polar regions became almost legendary.

Admiral Byrd's flight over the North Pole was made with Floyd Bennett in 1926, using a Fokker F.VII; and in 1928 he flew over



***RECUPERATED:** The Egyptian Air Force is reported to have been brought up to the strength it possessed before the Suez operation last year. Here pictured at a military airfield near Cairo a few days ago are Mig-17s—a type never before seen in such a detailed photograph.*

the South Pole for the first time, with Bernt Balchen as co-pilot, Harold June as wireless operator and Ashley McKinley as photographer, in a Ford Trimotor. He made his second flight across it during 1946-47—when he headed an expedition equipped with Dakotas, Martin Mariners, helicopters and 13 vessels—and his third and last (in a Skymaster) only fourteen months ago.

The Boscombe Dinner

CONCERN, hope and humour were intermingled in the speeches at the Aircraft Constructors' Annual Dinner, held at the Aeroplane and Armament Experimental Establishment, Boscombe Down, on March 15.

Welcoming the Controller of Aircraft, Air Marshal Sir Claude Pelly, the Air Commodore Commanding, A. Cdre. Ramsey Rae, remarked that many Boscombe facilities had been initiated by Air Marshal Pelly and by Mr. E. T. Jones; but he wistfully observed that still there was no new mess. When he took over command he was amazed by the enthusiasm and sense of purpose of the industry's technicians and specialists, and he hoped that these men would not now be thrown aside. It having been suggested that he himself must be something of an expert, he ruefully declared that the *ex* meant that one had had it—while a spurt was just a drip under pressure.

Sir Roy Dobson said that, in spite of rows, the industry and Boscombe had a healthy respect for each other. During the past fortnight he had been told that what was needed now was not fast aircraft but slow ones; so he proposed a return to the 504. There was a certain amount of gloom, he said, because politicians were behaving like a bull in a china shop. The aircraft industry had developed more new techniques than any other in the country, and was largely responsible for an electronic industry; but still we could not buy electronic gadgets off the shelf, as in the U.S.A. For stall-warning devices and auto-stabilizers "we ought to be able to go to Woolworths." Sir Roy concluded by recalling that there was a time when the industry, coupled with the Air Force, saved the world. "And if we don't mind," he added, "we shall have to do it again."

Air Marshal Sir Claude Pelly referred to Sir Roy as a TV star owning large slices of Canada. In more serious vein, he declared that we were facing very difficult times, and that the future was "thick with unreasonable possibilities." He thought that changes would be right and inevitable, for we must keep ahead technically; and if we meant to keep up our deterrent policy, we should have to shape our plans accordingly. He protested strongly against the current "catchphrase approach."

Sir George Edwards, who had just "burst into the U.K." after ten days in the U.S.A., enumerated massive tribulations which confronted him on his return, and prescribed hearty laughter. It had been implied that, in view of his civil commitments, he had no need to care what the Minister of Defence did. This Sir George stoutly denied; he would welcome any "crumbs" from Transport Command. One day, he said, we were told that we led the world; another day that it was a matter of too little and too late; another that it was "too much and too late"; and now it was "too much." Of slow aeroplanes he said that he had been trying to make them, without too much luck; and of missiles he remarked that robots being swallowed by robots reminded him of a certain fabulous bird (evidently well known to the assembly). He envisaged the Boscombe dinner becoming a Friday-night dining club, with members talking of "the happy days of the M.o.S."

Sir George concluded with a rendering of the following:

Aglint were all the megatrons,
The jittered clystons too,
With static splits and conical scan
The S.A.M.s were few.
But negative was the feedback
In the infra-seeking group,
For to add to the terror they'd made the error
Of forgetting to close the loop.

***AWARD FOR MERIT:** Mr. Aubrey Jones, Minister of Supply, presents the Segrave Trophy to Fairey test pilot Peter Twiss in recognition of his 1,132 m.p.h. record in the Delta 2. In memory of the late Sir Henry Segrave, the Trophy is periodically awarded by the Royal Automobile Club to "the British subject who has accomplished the most outstanding demonstration of the possibilities of transport by land, air or water . . ." The presentation was made at the R.A.C. on March 12.*

Boeing Intentions

WHEN it was suggested in America earlier this month that the Convair B-58 might be an intercontinental B-52 replacement (a view promoted by Convair), the market value of Boeing stock slumped. It rallied when the U.S.A.F. emphasized that at least 603 B-52s, and over 400 KC-135 tankers, were certain to be delivered.

Boeing Seattle are now engaged on an engine-conversion on the original XB-52. Under a £693,000 U.S.A.F. contract two pairs of Pratt and Whitney J57s are being replaced by one pair of the much larger J75s. A retroactive modification to production B-52s is most unlikely: the work is aimed at accelerating the high-altitude flight development of the J75.

Meanwhile, the company have received a follow-on contract for about £1,160,000 for "an advanced-type bombardment airplane." This is believed (by the *Seattle Times*) to be WS-110A (referred to on p.334 of last week's issue), which is stated to be "a chemically fuelled airplane capable of Mach three or four."

It has not yet been revealed which types of air-to-ground missile can be carried by the B-52, but the earlier B-47 is now equipped to carry the Bell GAM-63 Rascal. The Rascal-carrying machines are re-designated DB-47 (picture, p. 278, *Flight*, March 1).

W/C. Macmillan on the A.T.C.

SPEAKING of the place in society of the Air Training Corps, W/C. Norman Macmillan, commander of the Cornwall Wing A.T.C., said in a paper read before the Royal Society of Arts on March 13 that its great virtue was its capacity to train young men educationally, physically and in discipline and loyalty—and it was "important both to the R.A.F. and to the Merchant Air Force that a considerable body of air-minded and air-educated youth should form a good cross-section of the younger generation each year." Whatever the tendency towards "military robots and ballistic missiles" might be, there must be a period during which manned aircraft would still be required.

W/C. Macmillan said that one secret of A.T.C. success was the immense pride cadets took in their performance of parades. He had heard the c.o. of an Air Force station say he could always tell when an airman had been an A.T.C. cadet; there was an "indefinable polish" about his bearing which marked him out as having received pre-Service training during formative years.

We hope to give a more detailed account of the lecture in a forthcoming issue.

COMET 4 PRODUCTION at Hatfield was inspected on March 13 by Mr. Airey Neave (second from right), the new Parliamentary Secretary to the M.T.C.A. His host was Mr. A. F. Burke (right), D.H. Aircraft managing director. Others in the party were (left to right) Mr. C. S. Thom, D.H. business director; Mr. J. Peeler, Mr. Neave's personal assistant; and Mr. R. H. Walmsley, Assistant Secretary to the M.T.C.A. In the background is one of the first B.O.A.C. Comet 4s.

FROM ALL QUARTERS . . .

Cornell's BDM

AT the end of February, Cornell Aeronautical Laboratory, Inc. made an announcement regarding their work in the field of bomber defence by means of guided missiles (an account of the BDM programme was published in our "Guided Missiles" issue of December 7 last).

Cornell's principal responsibility has been guidance of the missile and, as the latter is launched in a rearwards direction, a variety of unusual aerodynamic, guidance and control problems have been raised. Using a specially equipped Raytheon Hawk (a surface-to-air missile of the U.S. Army), many test firings have been undertaken from supersonic sleds at Holloman A.F.B. to demonstrate that the system is feasible. Later firings may be carried out on the new Mach 3 sled which is now operational at Eglin A.F.B.

Engineering Education

DEPUTIZING for Sir Alfred Pugsley, Professor A. R. Collar, holder of the Sir George White chair of aeronautical engineering at Bristol, delivered the fourth Barnwell Memorial Lecture before the Bristol branch of the R.Ae.S. on March 13. He entitled his address *A Specification for Engineering Education.*

After discoursing in general terms on the place of engineering in society and upon the need for a greater output of qualified engineers, Professor Collar outlined the history of engineering education up to the present joint efforts of universities, technical colleges and company apprentice schools.

He then ranged far and wide over the whole field of engineering education, making his paper monumental in scope and stature. He concluded by offering his own suggestions on the way in which the country's strength of trained engineers of all kinds could be most efficiently and effectively increased.

His conclusions were: we must keep the British system, expand it, and build on to it methods from abroad which can produce necessary improvements; emphasis must be laid on the fact that engineering stood between the abstract sciences and the humanities, and had important contacts with both; schools should be encouraged to train intending engineers in both the humanities and the sciences, with emphasis on the common subject of mathematics; fluency in the use of English was very important; on the humanist side, we needed to give more attention to economics and management, history and industrial psychology—and on the scientific side to the problems of production; educational curricula should make it clear that engineering offered a challenge, and that both work and training in the profession could give real intellectual satisfaction.

Further, we must keep the flexibility of our present methods, by retaining a variety of avenues of learning and of qualifications to attempt; day-release methods must increasingly give way to "sandwich" schemes; craftsmen should be educated in trade schools by instructors versed in the latest methods; engineering apprentices should be increasingly trained by "sandwich" courses in residential colleges; engineering faculties in universities must expand; the 1-3-1 undergraduate apprentice system should be more widely used; post-graduate courses in special subjects should be provided; and the status of the engineer must be enhanced, possibly by the formation of a federation of professional engineers and by registration of chartered engineers.

Surveyors Supreme

IN a recent dispatch from Deception Island, Antarctica, John Saffery, deputy leader and flying manager of the Graham Land aerial survey expedition, which is being conducted by Hunting Aerosurveys, reported that 40,000 square miles—70 per cent of the contract area—had been photographed during the season which ended last month. The whole of the South Shetlands Islands, the Palmer Archipelago, the Biscoe Group, and Graham Land itself down to lat. 64 S. have been covered; and although " . . . it would have been nice," says Mr. Saffery, "to have had 100 per cent coverage, 40,000 square miles on a mountainous peninsula and a string of craggy islands would be difficult anywhere in the world," and in Antarctica "is indeed a tough assignment." He points out that the 30 per cent not yet photographed is largely on the Graham Land plateau, which is "featureless ice-cap . . . nearly always obscured by a thin layer of cloud," so that photographic runs across it tend to consist "largely of white paper."

Mr. Saffery, who with his pilots and navigators was recently awarded the Johnston Memorial Trophy for this year's outstanding navigational feat, pays tribute in his report to the "skill and determination" of the crews flying Canso amphibians from Deception Island on this work, across mountainous, glaciated and barren country forming a "nightmare landscape." Even so, flying and photography form only half the expedition's work; scaling and triangulation control points have to be established on the ground, so that the exact location of photographed features can be determined.

"Flight" photographs

VERSATILE CONVERSION: The first two Thruxton Jackaroos in the air, photographed last week. One is the four-seater, the other the crop-duster or freight (500 lb) interchangeable version. This ingenious and modestly priced (under £1,000) Tiger Moth conversion was originated by S/L. J. E. Doran-Webb, managing director of the Wiltshire School of Flying, Thruxton, Andover, and Mr. R. Prizeman.

Seen here in Short's factory at Queen's Island, Belfast, is the first Britannia 305 for Northeast Airlines. It is likely to fly—the first Short-built Britannia to do so—in a few weeks' time.

CIVIL AVIATION

TRANSATLANTIC BRITANNIA

WE recorded last week that the first long-range Britannia 312 had returned to base at Bristol after its cold-weather trials in Canada and subsequent demonstrations in the U.S.A. The flight home is significant in that it was the first practical evidence of the new Britannia's long-range capabilities.

At New York (whither G-AOVA flew from San Francisco) the Bristol crew, headed by Walter Gibb, decided to cover at least 4,000 n.m. on the next leg to assess long-range fuel consumption. The aircraft was therefore flight-planned to fly non-stop to Rome.

The Britannia took off from Idlewild at maximum gross weight (175,000 lb), with an 18,000 lb payload, and was flown according to the stepped-climb-cruise procedure (see *Flight*, February 1, page 142). A series of 2,000ft climbs were made every two hours from an initial altitude of 19,000ft to a final altitude of 29,000ft. By utilizing the prevailing pressure-pattern, which took the aircraft off the Great Circle route and southwards over the Azores, a tail-wind component of 30 kt was experienced. If the most direct Great Circle route had been taken between New York and Rome a head-wind of 28 kt would have been encountered, though the exact distance covered (4,050 n.m.) would have been 350 n.m. less. The net gain—proving the advantages of so-called jet-stream flying—was approximately one hour's flying. Total flying time was 12 hr 10 min (within six minutes of flight-plan), and the average speed 335 kt.

A fuel check at Rome showed that the tanks still contained 1,040 Imp. gal—sufficient for a further 2 hr 20 min of cruising.

R.E.A.L. HOPES FOR THE ELAND

IT is understood that the Brazilian airline R.E.A.L., which operates a fleet of five Convair 340s and ten 440s, has placed an order with D. Napier and Son, Ltd., for 30 Eland engines in order to convert their Convairs to turboprop power. The Napier company do not deny this report, but state that negotiations with several operators are "very near to completion."

If the R.E.A.L. order materializes it will represent the long-awaited Napier breakthrough into the turboprop-conversion market. The case for conversion was only recently restated by Mr. H. Sammons, Napier's managing director, in a paper read before the Royal Aeronautical Society (*Flight*, March 8).

THE DC-7D AGAIN

NEARLY three years ago, before the U.S. aircraft industry made its historic decision to go ahead with the big jet transports, both Douglas and Lockheed were working on turboprop versions of their piston transports. These were respectively known to the airlines as the DC-7D (*Flight*, August 6, 1954) and L.1549. Neither project was proceeded with, although Lockheed produced a 1049B fitted with Pratt and Whitney T34 turboprop engines for the U.S. Navy and known as the R7V-2.

We now learn from an American source that Douglas are re-examining the possibility of providing the DC-7C with turboprop power. The engine concerned—as in the 1954 studies—is the Rolls-Royce Tyne, and the report (in *American Aviation Daily* of March 14) states that Douglas are "actively exploring the possibility of building a new DC-7D cargo transport," and that the two main prospective customers are American and United.

The implications of this report could be far-reaching, especially if it means—as Douglas no doubt hope it to mean—extension of the long-established DC-6/7 production into the sixties. No doubt Lockheed have not overlooked the possibility of re-engining the Super Constellation with turboprops.

LOCKHEED'S EXECUTIVE JET

A SURPRISE announcement from Burbank last week stated that Lockheed have decided to build an 8/10-passenger "jet utility trainer transport," and that *a prototype will fly in six months' time*. This aircraft will, it seems, be a direct rival to the Fairchild M-185 (*Flight*, September 14, 1956).

The background to this important decision may be traced to a specification issued last year by the U.S.A.F. Air Materiel Command for two distinct types of small jet transport. Each was to be designed for "five-star-general" transportation and for crew-training. One specification called for a twin-engined, six-seat aeroplane with a range of about 1,500 miles cruising at 550 m.p.h. The other specified a four-engined ten-seat transport, also with a 550 m.p.h. cruising speed. It was to the latter specification that Fairchild designed the M.185 (four Fairchild J83 engines of 2,000 lb thrust).

The most significant point about each specification was that the U.S.A.F. deliberately took into consideration the requirements of the commercial executive market. There appears to be no doubt that this "businessman's jet" market, as we have remarked in these pages before, is likely to be extremely large in the 1960s.

TIREDNESS IN THE COCKPIT

IN these pages last week we set out the reasons for the pilots' dissatisfaction with the proposed legislation to govern flight-time limitations. In a statement to *Flight* the Guild of Air Pilots and Air Navigators assess the new Order and give a recommendation which, they hope, will increase its effectiveness.

"It appears," say the Guild, "that unless the Minister is prepared to give certain assurances on the application of this legislation, safe flight may well be jeopardized and the most vexatious problem may be created for both operating crew and operators of public transport aircraft.

"The proposed legislation places the responsibility on the operator for laying down time limitations to be observed by flying staff. Overriding limitations are detailed in paragraphs 34D, E and F of the Order. These time limitations are at variance with, and in many important respects be contrary to, the recommendations of the Guild and its medical advisers. These recommendations were made available to the Minister from the outset.

"At present, operating schedules are produced by the operators, in consultation with their flying staff, without Ministerial control or guidance. The proposed legislation provides the control and guidance, and its practical effect may be studied.

"For example, paragraph 34E (b) limits the duty period of a two-pilot operation to 16 hours. Such an operation may extend from an aircraft on short flights with a high frequency of landings, and of which the two pilots constitute the entire crew, to the longest-range aircraft on long hauls, and on which a navigator, radio officer and engineering officer are carried in addition to the two pilots. The figure of 16 hours may be reasonable for some long-range types of operation, but it is grossly excessive for many other operations falling within its scope. The way is left open for operators to extract the longest possible working hours compatible with safety from their flying staff, as costs are linked to this factor. The new legislation would seem to give official approval for a very considerable extension of the present working periods for the majority of short-haul operations involving aircraft manned by one or two pilots. Information in the hands of the Guild indicates that some operators may attempt to take advantage of this situation.

"Control is defined in paragraph 34B (8), which states that the operator's own limitations must be available for examination by the Minister. Prior approval of operating schedules is not prescribed. It thus appears to the Guild that the value of the legislation will depend upon the energy and efficiency with which this control is applied. It is suggested that the Minister should set up a board to which matters of flying fatigue may be referred. As fatigue is a complex and intangible subject on which there are no recognized authorities, the board should be widely representative and include active operating crew members and medical representatives who are constantly in touch with the problem. The Guild would be able to assist the Minister by submitting the names of individuals who have made a special study of the subject."

Footnote: Pilot fatigue has been given as one of the probable causes of the Britavia Hermes accident at Blackbushe on November 5. The report of the court of inquiry, published last Wednesday (and which we hope to review next week) submits that the captain was "suffering from a degree of fatigue above the normal" and that in difficult conditions he judged his height during an I.L.S. approach to be greater than it actually was.

An increase in cruising speed—from 609 m.p.h. to 615 m.p.h. (Mach 0.93)—is estimated by Convair for the 880 medium jet transport following work with tunnel-models, one of which is shown here. The tailplane is now fuselage- instead of fin-mounted, and the outer pods have been moved further out. Take-off weight is now up by 5,000 lb to 178,500 lb—but for the same empty weight and a five per cent reduction in take-off distance.

CIVIL AVIATION . . .

I.C.A.O. AT WORK

IN Paris in January this year, I.C.A.O.'s Implementation Panel (the "Jet-Age Task Force") met to consider the air navigation facilities and services in the European and Mediterranean region. We reported their findings in our issue of February 15, before the Panel's recently-documented formal comments and recommendations were issued from the I.C.A.O. headquarters at Montreal.

The full report—which covers the civil-military situation, aerodromes and ground aids, communications, meteorology, A.T.C. and regional planning—draws attention to some dangers and deficiencies in the region and makes some straightforward recommendations. These we summarize below (in italics).

(1) Aerodromes have been well developed but a number still lack the needed approach lights. *Where called for in the regional plan, states should give high priority to the provisions of approach-light and runway-light installations to the I.C.A.O. standard.*

(2) The Aeronautical Fixed Telecommunications plan has been largely implemented but the required speed of message handling has not, in general, been met. *All states should establish regular checks on the time taken to handle messages at their stations and should examine the procedures and ensure proper training of personnel.*

(3) Imperfections in planning contribute to the unsatisfactory provision of services and facilities. *States participating in the forthcoming regional meeting should adopt a liberal attitude and work towards an integrated plan for the region as a whole.*

(4) In the development of uniformity of training in air traffic control systems more advantage could be taken of the work of I.C.A.O. *European governments should study this matter carefully and initiate such action as they find advisable.*

The Panel also remarks upon errors in upper-wind forecasts in the Mediterranean area. This subject is to be discussed with individual states where implementation of the upper-air network plan had been retarded. They also note in their report that the best hope of resolving civil and military difficulties lies in the expanding use of the machinery set up by the Committee for European Airspace Co-ordination.

Meeting in Montreal at the moment is the Aerodromes, Air Routes and Ground Aids Division of I.C.A.O., the body to whom the Jet Operations Requirements Panel (complementary to the Jet-Age Task Force) and the Fire-fighting and Visual Aids panels report. The subject for discussion at this sixth session is to amend the Organization's *International Standards* and *Recommended Practices* to keep them in line with technical progress. The division will make reference to the report of the recent meeting of the Jet Operations Requirements panel who have sifted the design characteristics of individual jet aircraft, and made recommendations and observations about their operation. The division will also undertake a complete review of aerodrome design in all its major aspects, taking into account "the changing requirements of new aircraft types."

THE OTHER A.R.B.

CERTAIN misconceptions about European air transport were recently corrected by the head of the Air Research Bureau, Mr. Bo Bjorkman. This other A.R.B., it will be recalled, is the organization in Brussels which undertakes research into European air transport for the common benefit of Air France, K.L.M., Sabena, Swissair, B.E.A., S.A.S. and Lufthansa.

Addressing the Air Transport Development Centre in Rome, Mr. Bjorkman quoted a paper (unnamed) comparing European and U.S. operations: *"Passenger traffic volume, route planning, scheduling, payload factors, operating costs . . . no matter which criterion is taken, there is no question that the Old Continent does alarmingly badly."* No mention was made, said Mr. Bjorkman, of the fact that in 1955 European air traffic increased at a higher rate than air traffic in any other region in the world.

Again (he quoted another paper) *"air fares in Europe are twice as high as in the U.S."* The correct comparison was that European domestic fares were 13 per cent higher than U.S. domestic and 4 per cent *lower* than U.S. local service fares, and that European international fares were on an average 8 per cent higher than U.S. international fares. These percentage differences were, he said, quite small compared with the 100 per cent difference indicated.

BY EAGLE TO THE U.S.?

PLANS to operate inclusive tours between Europe and the U.S.A. and Canada in 1958 are being made by Eagle Aviation in co-operation with Lunns Travel Agency. The proposal is subject to the approval of the Air Transport Advisory Council and, if the application succeeds, the tours would be operated in conjunction with "an American air carrier." Already, state Lunns, the use of Super Constellations for the transportation of holidaymakers has been arranged. The American carrier referred to could be T.W.A., the only U.S. Atlantic passenger airline with L.1049s.

WEST LONDON TERMINAL

THE new London air terminal which is being built over the underground railway adjacent to the Cromwell and Gloucester Roads should, it was announced last week, be completed in four and a half months. Sponsored by Air Terminals, Ltd., the prefabricated building will cost over £250,000. It will be of delta shape and will have two storeys; the lower will contain the departure and arrival halls, lost property office, bank and a hotel reservations counter, and the upper will contain a passenger lounge and buffet. An air-parcels office will arrange the despatch of small urgent parcels to the airport.

BREVITIES

FOR the first time, East African Airways are to run services to the United Kingdom. Starting on April 2, they will be operated by B.O.A.C. until E.A.A. receive their three ex-B.O.A.C. Argonauts.

* * *

The joint inquiry into the T.C.A. Viscount accident on July 9 last (when a propeller blade came off in flight and killed a passenger) suggested that the captain "executed an emergency descent at nearly maximum speed" after reduction gear failure, causing propeller r.p.m. to increase until loads exceeded the design blade-retention strength.

* * *

Certificates of commendation have been awarded by Mr. Gerard d' Erlanger to five former members of B.O.A.C.'s staff in Egypt. All played an important part in the care and evacuation of Britons. The awards went to Messrs. H. J. Bingham, B. S. Bridge, D. W. Davies, R. W. G. Terry, and D. C. Picard.

* * *

We record with regret the sudden death on March 13 of Mr. R. J. Cooper, training manager of B.O.A.C. He was first associated with the Corporation in 1943, after a 15-year R.A.F. career in which he attained the rank of group captain. He was 49.

* * *

It is reported that Indian Airlines are likely to order the Fokker Friendship. It has been known for some time that the company has been evaluating this aircraft and the Il-14.

* * *

The new Antonov turboprop (*Flight*, March 8) has "made its appearance over Kiev," according to a Moscow broadcast.

* * *

The Boeing 707 flew from Seattle to Baltimore on March 11 in three hours 48 min. Average speed was 612 m.p.h.

* * *

C.A.A. certification of the Lockheed L.1649A is expected during the next few days.

HERE AND THERE

Helicopter Carrier

FIRST ship to be designed from the outset as a helicopter carrier, a 10,000-ton vessel is to be built by France. As well as accommodating 12 large helicopters she will be formidably armed with 12 four-inch guns. Her complement will be 1,050 men, speed 26½ kt and range 6,000 miles.

Supersonic Silence

IN the House of Commons last week the Minister of Supply, Mr. Aubrey Jones, said "it would not be in the public interest" to disclose the size of the P.1 production order or to state when the aircraft was expected to come into service.

Airing the Industry

FOR information on the aircraft industry in a programme scheduled to be broadcast last night as part of a North Regional series called *Industrial Inquiry*, B.B.C. recording units had visited Blackburn and General Aircraft, English Electric, Short Brothers, Faireys and other firms.

M.o.S. Appointment

WITH the agreement of the Secretary of State for Air, the Minister of Supply has appointed A.V-M. G. P. Chamberlain, C.B., O.B.E., to be Deputy Controller of Electronics. A signals specialist and a former chief signals officer of R.A.F. Transport Command, A.V-M. Chamberlain was due to take up his post last Monday.

G/C. Sidney Smith

WE regret to record the death—at Farnham, Surrey, on March 12—of G/C. Sidney Smith, D.S.O., A.F.C., R.A.F. (retd.). An Army officer from 1909, he learned to fly in 1915, and served with distinction in the R.F.C. His R.A.F. appointments in the inter-war years included the command of the A. and A.E.E. He was 70 years of age. G/C. Sidney Smith's name, incidentally, should not be confused with that of another retired officer, A. Cdre. Sydney W. Smith, C.B.E., D.L.

HUSTLING SLOWLY: The world's biggest bomber, a Convair B-36, is here depicted carrying the world's fastest bomber, a Convair B-58. Static testing of the B-58 airframe is being undertaken by Wright-Patterson A.F.B., Dayton, Ohio. It was found that the most economic method of getting the test specimen to Dayton—from Convair Forth Worth—was to transport it as shown here, minus powerplants and systems. The B-36's inboard propellers were removed to provide clearance for the B-58 wing—of delta form and of 57ft span.

Ilyushin Replacement

A RUSSIAN offer of another aircraft to replace the Il-28 which caught fire on February 26 has been accepted by Mr. Nehru, the Indian Prime Minister, who was a passenger when the first aircraft had to make an emergency landing.

Fourth Fison Whirlwind

A FOURTH Whirlwind has been ordered by Fison-Airwork from Westland Aircraft. With the third—ordered in January—it will be shipped to Nigeria for operations with the two Fison-Airwork helicopters under charter to the Shell-B.P. Petroleum Exploration Co.

Capital Expenditure Urged

AT a gathering of north-western industry representatives in Manchester last week, Sir Roy Dobson, managing director of A. V. Roe and Co., Ltd., said that if Britain were to keep her place in the engineering world "an awful lot more money would have to be spent on equipment." He also urged "some sort of amalgamation" between employers and trades unions on wages and other problems.

Alizé for R.A.E

A PROTOTYPE of the Bréguet 1050 Alizé anti-submarine aircraft (Rolls-Royce Dart) is shortly to undergo catapult tests at the Royal Aircraft Establishment, Farnborough.

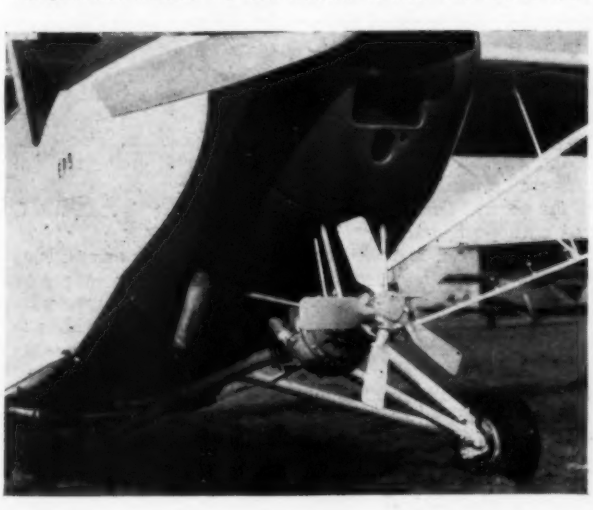
Australian Antarctic Flights

WITH the return to Melbourne of most of the 1956 Australian Antarctic expedition it was reported that during their stay at Mawson, the main Australian base, flying operations had been kept up throughout the winter; 115 flights, covering 50,000 miles, had been made by the expedition's ski-equipped Auster.

Presentation to "Tim" Morice

A BOOK containing over 100 signatures of those with whom he worked in Coventry and inscribed "with the greatest affection to Tim Morice" was recently presented to G/C. C. S. Morice by Mr. J. Wright, director of the Dunlop aviation division. G/C. Morice's retirement from the company, after nearly 30 years' connection with it, was recorded in *Flight* for Jan. 18.

FAN FOR FARMERS: Originally, the Edgar Percival E.P.9 agricultural aircraft was built principally for dusting and top-dressing. These photographs, taken at Stapleford Tawney last week, illustrate the fan-driven pump and spray bar fitted to the first EP.9 to be sold in Europe. This particular machine has been delivered to Ernst Ludt K.G. of Hartenholm, West Germany. It will be used chiefly for spraying fruit crops.
"Flight" photographs



The Fleet Air Arm

INTRODUCING AN ILLUSTRATED "FLIGHT" REVIEW OF BRITISH NAVAL AVIATION TODAY

TO the men and women of the Fleet Air Arm this issue comes as a simple tribute—to their many skills and talents, to their loyalty, and to their exceptional blend of enthusiasm and responsibility. Their standards (and our admiration) are the highest. We believe that the story of their work today is well worth telling. To help us tell it, we invited the co-operation—readily given—of the senior officers whose messages are on these two pages, of the Director of Naval Air Warfare, and of the gifted inventor of the mirror sight. And we of *Flight* travelled thousands of miles to visit Naval air stations in the United Kingdom and carriers in the Mediterranean, receiving full facilities and true hospitality everywhere. The overall picture is built up from this page onward—the Fleet Air Arm's general rôle; the work of Home Air Command; front-line aircraft and ships; Naval air warfare philosophy and technical developments; impressions of peace-time carrier flying; and a reminder of carrier flying in earnest.

In the six years since our last special issue of this kind much has happened in Naval aviation. A new generation of aircraft has appeared and is serving with the Fleet, and some of the most significant advances in operating technique since carrier flying began have been adopted. Now the next generation of the Navy's aircraft, in the form of the Scimitar and later the Sea Vixen, are expected. With the shadow of defence economies causing uncertainty in many parts of Whitehall as we write this, the future of the Fleet Air Arm is not crystal-clear. Its future *potential*, however, can be gauged from its present strength—as indicated by the three important messages which follow.

From Vice-Admiral A. N. C. Bingley, C.B., O.B.E.,

DEPUTY CHIEF OF NAVAL STAFF AND FIFTH SEA LORD

WHAT is the Fleet Air Arm? What is it for? What can it do? What can it not do? There is no subject connected with Defence about which more people know less.

Widespread ignorance of the functions, capabilities and limitations of aircraft carriers and their aircraft is at the root of most of the arguments about their value. Thinking on defence matters is left too much to those who are paid to do it. The average man has little concern with our needs and responsibilities overseas until reserves are called up and casualty lists appear. This is wrong. An enlightened democracy should have an understanding of the country's defence problems, and an influence on decisions about the number and kind of weapons it can afford; the difficulty for the ordinary citizen is to get the facts in a form which he finds entertaining and easy to read, and which he can understand.

This special issue of *Flight* will, I hope, give to the "average man," both inside and outside the Services, factual information about the Fleet Air Arm on which to base his discussions and reach an informed view. It is for this reason in particular that I welcome it.

The rôles of ship-borne and shore-based air power are complementary: an examination of the main differences between them makes this clear.

The carrier is mobile, the airfield static. This means that the carrier can get to troubles in most parts of the world, whereas the airfield can only influence those within range of its aircraft, though it should be able to do so more cheaply and efficiently than the carrier.

Most airfields operate only one type of aircraft and thus enjoy the organizational and logistic advantages of specialization: nor are they subject to the restrictions of size and approach-speed which govern the design of naval aircraft. The carrier, on the other hand, is usually complemented with several types of aircraft: moreover, each type is equipped and its crew trained to do some other job effectively when not required in its primary rôle.

The carrier thus provides a less massive but more flexible form of air power, whereas the airfield and its aircraft can better meet a particular need such as fighter defence of our island. The carrier gets certain tactical advantages from her mobility; she can, for example, to a great extent choose the range, and sometimes the weather, which is more advantageous to her than to the enemy. On the other hand, she is subject to the hazards of the sea, both natural and enemy-originated.

The airfield is cheaper than the carrier and normally lasts longer, but our airfields overseas are often subject to the play of international politics and may no longer be available for our use when we need them most. They may even come to be used against us.

With these basic differences in mind it is not too difficult for anybody who is willing to put his mind to the problem to decide which of our world-wide defence commitments are best provided for by means of carriers and ship-borne aircraft, which by airfields and shore-based ones, and which by a bit of both: readers will draw their own conclusions on the matter. The truth is that each sort has its uses and advantages, and we need both. The problem is, in fact, not so much the military one of deciding which form of air power to provide for any given commitment, as the political one of deciding which commitments we must be able to meet.

From Admiral Sir Caspar John, K.C.B., LATELY FLAG OFFICER AIR (HOME)

I AM very pleased to contribute a message for this issue of *Flight*, the publication of which coincides with the end of my present appointment as Flag Officer Air (Home). This official commands the Home Air Command, which consists of all Naval air stations and air establishments in the United Kingdom. It is a Command with responsibility direct to the Admiralty. Its task is to provide the aircraft carriers of the Fleet and all Naval air stations with their air components; that is to say, trained aircrew, up-to-date aircraft, and officers and ratings trained to maintain and operate those aircraft.

The Command is subdivided into three sections, one concerned primarily with operational flying training of both individuals and squadrons; a second concerned with training artificers, mechanics and the wide variety of trades required for modern aircraft; and a third concerned with the whole range of aircraft supply, repair and overhaul—from factory to Fleet. None of these jobs could be done so well, if at all, afloat, and although most of us would rather serve at sea we realize the necessity for an efficient and flexible shore organization to support the operational part of the Fleet Air Arm.

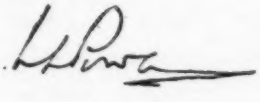
We have a host of amicable connections with the Army and the Royal Air Force and Civil Defence, and we are closely integrated with their activities where there is practical common ground.

I can sum up our task as one of providing the human and material ingredients of a versatile and mobile Fleet Air Arm, whose demands range world-wide and keep us very much on the alert and flexibly-minded. We would consider we had failed if we did not match the requirements of the aircraft carrier's great mobility.

This issue of *Flight* also happens to coincide with my personally severing a close connection of some 32 years with the Fleet Air Arm. With infrequent breaks, I have been directly associated with its development from a very tender plant to today's sturdy growth.

I have never known the Fleet Air Arm in better heart or better shape than it is today and I judge it to be relatively a far more effective weapon system than ever it has been.

From Vice-Admiral M. L. Power, C.B., C.B.E., D.S.O., FLAG OFFICER AIRCRAFT CARRIERS



THE Flag Officer Aircraft Carriers has the privilege of commanding the spearhead of the Navy, and included within that is, of course, the higher privilege of commanding the fine body of officers and men who fly from and man the ships. I therefore welcome this opportunity of saying something of the work and rôle of the aircraft carriers.

Much has been done, by British inventiveness, to ease the difficulties of flying high-performance aircraft from and to the deck; nevertheless, carrier flying remains a specially skilled and inherently hazardous operation demanding a very high standard of discipline and training from aircrew and a very high standard of maintenance in ships and aircraft.

These high standards are forthcoming in the air squadrons provided for me by the Home Air Command and in the ships by intensive training of their companies by their individual captains.

It is perhaps worth stressing that the aircraft carrier contains within her probably the highest level of teamwork that can ever be met. The end product is the aircraft performing its task in the air; but behind that lies a most complex organization interlocking at all points and involving everything from the domestic needs of thousands cramped within a small space through seamen, engineers, electricians, armourers, communications, a direction organization equivalent to a sector operations room to, finally, that epitome of co-ordinated drill—the flight-deck and hangar organization.

Now where does all this lead and what is it for? The aircraft carrier or carriers (for they should work in pairs or more) combines the tactical mobility of the aircraft with the strategic mobility of the ship. She can provide an operational airfield where and when it is required. Her task, whether in attack or defence, is primarily offensive. Her aircraft seek out the enemy, whether in defence of the Fleet against bombers or submarines, or whether in attack against enemy ships, bases or airfields. She is the essential core of the modern Navy upon which the continued nourishment of our nation depends in major war. It is to be hoped they will not be called upon again to prove their worth in that; but in the uneasy peace which prevails in our time, local or limited wars are an ever-present danger.

The moment danger threatens, the carriers are called upon. In Korea virtually the entire British air effort was carrier-borne and maintained over three years. Their performance was outstanding. In the Egyptian incident the Anglo-French carrier force bore a generous fifty per cent of the whole Allied air effort and provided all the ground support of troops. They are ready at short notice now to do likewise in any part of the world where they may be called upon to act.

Our responsibilities remain world-wide. Our bases, alas, are no longer so. The carriers fill the gap. As Kipling said, "It is not the big stick that counts, it is the liftable stick."

Typifying the anti-submarine rôle: Gannets from the Anti-submarine School at Eglinton fly over the coast of Northern Ireland.

Structure of the Service

FLEET AIR ARM ORGANIZATION AND THE WORK OF HOME AIR COMMAND

ILLUSTRATED MAINLY WITH "FLIGHT" PHOTOGRAPHS

IN an essay entitled *First Impressions of the Fleet Air Arm*, written recently at the end of a ten-day familiarization course at R.N.A.S. Brawdy, a Dartmouth cadet of the Royal Navy wrote: "I do not blame the aviators for being enthusiastic about flying, but I think they get slightly fanatical and narrow-minded and cadets are liable to become affected if they listen too carefully."

This sentiment—*not* specially written for this particular issue of *Flight*—is understandable, coming from someone making his first contact with Naval aviation. We would merely add, however, that the more R.N. cadets who do become affected the better—for the Navy and for the country. Some idea of the reasons for the enthusiasm, we hope, will be apparent from the messages and other articles in this issue. Here we are concerned with the background to the enthusiasm—a rough sketch of the framework on which the operations of the Fleet Air Arm are based.

An appropriate place to begin is in the room of the Fifth Sea Lord, overlooking Whitehall. Within the Admiralty he is responsible for the fighting efficiency of the Fleet Air Arm, including all questions of operational tactics and technical policy. Directly under the Fifth Sea Lord are two staff divisions, concerned with Naval Air Warfare and Naval Air Organization and Training respectively. The latter, D.A.O.T., is also responsible to the Second Sea Lord (who is the Chief of Naval Personnel) for training.

Two other divisions at the Admiralty are concerned with the procurement and maintenance of aircraft and equipment. These are D.A.E. (air equipment) and D.A.M.R. (aircraft maintenance and repair), and they are responsible through the deputy controller to the Third Sea Lord (controller).

In these four divisions of the Admiralty, then, the various aspects of Fleet Air Arm activity and equipment are studied and policy is decided. The Ministry of Supply is responsible for meeting Admiralty requirements for aircraft and equipment, and a senior Naval officer is Deputy Controller of Aircraft there. In addition, a number of Naval officers are employed as project officers in various directorates at the Ministry; they maintain close liaison with D.A.W. and D.A.E., with Government establishments such as R.A.E., and with the aircraft industry.

Broad policy established by the Board of Admiralty, its implementation rests with the Flag Officer Air (Home)—as it concerns the Naval air stations in the United Kingdom—and (through the commander-in-chief of the Home or Mediterranean Fleet, as appropriate) with the Flag Officer Aircraft Carriers as it concerns the operational carriers. The respective tasks of these two flag officers are amplified in their contributions to this issue (page 363).

The remainder of this article is concerned with the work of Home Air Command in producing trained and equipped fighting units for service in H.M. carriers. This work is carried out at air stations and establishments in England, Wales, Scotland and Northern Ireland, with overall direction from the Home Air Command headquarters at Lee-on-Solent.

The Command's simply expressed aim of combining men, aircraft and equipment into effective fighting units as operational squadrons is by no means simple to achieve. Within the framework of requirements and timing laid down by Admiralty, Home Air Command has two main responsibilities—to obtain and train the men, and to provide and maintain the aircraft.

Flying training and ground training are separated, logically, which results in three major "pipeline" systems under Flag Officer Air (Home). These three are headed respectively by Flag Officer Flying Training (F.O.F.T.), the F.O.A.(H) staff captain concerned with ground training, and Flag Officer Reserve Aircraft (F.O.R.A.). Of the Naval air stations and other F.A.A. establishments in the United Kingdom, six are concerned with flying training, three with ground training, and six with the provision and maintenance of aircraft, while Lee-on-Solent accommodates units of all three, plus other specialist sections. In addition, there are "care and maintenance" and reserve stations, flying units operated by civilian firms, and Fleet Air Arm sections at various R.A.F., M.o.S. and other establishments.

In January of this year National Service aircrew training was terminated, and pilot and observer entry is now from two sources only, fleet entry [permanent general-list officers and upper yardmen (air)], and civilian entry for 12-year commissions on the supplementary list. Under the Navy's new officer structure, pilot candidates from the fleet entry source would be either seaman or engineer specialists of the general list, or upper yardman (air).

Thus pilot candidates enter the pipeline as midshipmen or sub-lieutenants (seaman specialists on the general list); lieutenants

STRUCTURE OF THE SERVICE . . .

(seaman and engineer specialists having obtained watchkeeping certificates and (in the case of the engineers) completed two-year air engineering course); upper yardman (air) (rating candidates for supplementary list commissions); and aviation cadets (civilian entry to supplementary list).

Before being accepted for pilot training, both Service candidates and civilians must pass aptitude tests at R.A.F. Hornchurch, undergo medical examination at Seafield Park, and attend interviews at London and Gosport. Upper yardmen (air) then undergo a 30-week course at H.M.S. *Temeraire*, a shore establishment in Scotland, after which they become midshipmen or sub-lieutenants; while aviation cadets go to sea for 25 weeks' training with the training squadron (H.M.S. *Theseus* and H.M.S. *Ocean*), also passing out as midshipmen or sub-lieutenants.

Flying training up to wings standard is provided by the R.A.F., first at No. 1 F.T.S. at Syerston (60 hr dual and 60 hr solo on Provosts), followed by 55 hr dual and 45 hr solo on Vampire T.11s and 5s at No. 7 F.T.S., Valley. Both these establishments are devoted almost entirely to the training of Naval pilots, and a large number of Naval officers are attached to these units. After wings have been awarded at Valley, Naval pilots branch into two streams for applied training, continuing either to Lossiemouth (fighters) or to Eglinton, Northern Ireland (anti-submarine aircraft).

Observers enter from the same sources as pilots, except that engineer officers do not sub-specialize as observers. The same initial lines of entry are followed, until the observers branch off to R.N.A.S. Culdrose, Cornwall, for their main nine-month course at the Naval Observer and Air Signal School. Also trained at this school are Telegraphists (Air).

The observers' training at Culdrose (H.M.S. *Seahawk*) is divided into three phases, and there are two air squadrons attached to the school to provide the flying experience required. The first phase, lasting eleven weeks and devoted to electronics, gives the students some 40 hours' flying (day and night) in Sea Prince aircraft. These machines are operated by 750 Squadron.

A student's flying aptitude is checked at the end of this stage. He next flies in the Firefly 7s of 796 Squadron for about 70 hours, 75 per cent of the time as observer and the remainder as telegraphist. Navigational training is the theme of this phase. Ground instruction (which began in the first stage with basic radio, radar, navigation and associated subjects) is continued and expanded.

The Fireflies of 796 (soon to be replaced by Gannets) are used also for the third part of the course, devoted to scouting (i.e., reconnaissance) work. On the air side the work consists mainly of tactical exercises, with a scouting emphasis; while ground instruction is continued and includes radio warfare (the detection, location and jamming of radio and radar transmitters). The total flying time during the course is about 180 hours, including a short period of jet flying in the Venom 21s of 766 Squadron at Merryfield.

Telegraphists (air) spend seven weeks on course at the school. They then move (as do the observers) to Eglinton for advanced training.

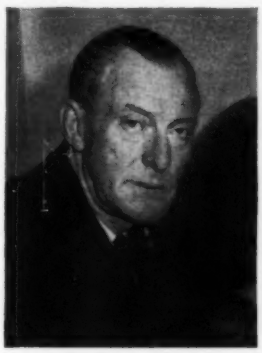
To Eglinton, then, come all newly qualified observers and telegraphists, together with those newly qualified pilots selected for the anti-submarine rôle. Located not far from Londonderry, on the shore of Lough Foyle, the air station bears the name H.M.S. *Gannet* and, naturally enough, is the home of a large gaggle of Fairey products of the same name.

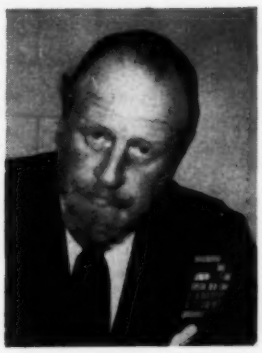
The full title of the training unit there is the Naval Air Anti-submarine School, which comprises two training squadrons and a ground school. One squadron provides a twelve-week Gannet conversion course for pilots, and the other a seven-week course for observers and a four-week course for telegraphists. Close co-operation is maintained with the Joint Anti-Submarine School at Londonderry, and realistic training devices are used at both establishments.

Pilot training is the responsibility of 737 Squadron, equipped with Gannet AS.1s and T.2s. At least 50 hours' flying is logged by pilots from Valley on a normal Gannet conversion, most of which is type familiarization, although a number of elementary anti-submarine exercises are included. More-advanced anti-submarine exercises are covered during the squadron work-up phase. The station's elaborate Gannet simulator, made by Redifon, is put to good use in teaching pilots engine-handling before flying the actual aircraft, and in giving instrument-flying practice.

Observer and telegraphist training at Eglinton is carried out in the Gannet AS.1s of 719 Squadron, whose broad aim is to turn the newly qualified men from Culdrose into operational observers. Anti-submarine exercises, simulated and real, form the main body of the course: patrols (using standard NATO procedures) and joint exercises with ships and submarines from Londonderry are fitted into a gradual but thorough work-up.

Observers and telegraphists normally fly about 40 hours and 20 hours respectively during the Eglinton course. An interesting point is that *all* observers follow up their wings course at Culdrose with the anti-submarine training at Eglinton, which is considered a basic application, although some will later take up early-warning or all-weather fighter duties. Another aspect of 719 Squadron's rôle is in effect that of a pilot holding-unit.





Right, Flag Officer Air (Home), Vice-Admiral W. T. Couchman, C.B., C.V.O., D.S.O., O.B.E. Below, his two flag officers, Rear Admiral J. D. N. Ham, C.B. (left), Flag Officer Reserve Aircraft; and Rear Admiral C. L. G. Evans, C.B.E., D.S.O., D.S.C., Flag Officer Flying Training.

From Valley, those newly winged pilots not allotted to anti-submarine flying would have journeyed to Lossiemouth, Scotland, and arrived at the Naval Air Fighter School. Here again there are two constituent squadrons, backed up by a thorough ground-training and armaments structure.

The main function of 736 Squadron, equipped with Sea Vampire T.22s, has been to provide a one-month course for American-trained pilots designed to acclimatize them to British methods of instrument flying, high-level and low-level navigation, and night flying. These pilots fly 30 sorties during this course, ten of which are devoted to dual instrument flying. Fleet Air Arm pilots are no longer being trained in the U.S.A., although the flow of trained pilots from this source is only now tailing off. Those arriving from Valley would normally spend a much shorter time checking-out with 736. Other tasks of the squadron include dual continuation training of O.F.S. students and front-line squadron pilots, and weapon-firing and interception courses for gunnery and director specialists.

From 736, pilots convert to the Sea Hawk on 738 Squadron, which claims to be the "finishing school" for all Fleet Air Arm student fighter pilots. A ten-week operational flying course is given to the R.A.F.-trained pilots from Valley; during this time 50 hours' flying time is logged, including air-to-air firing, ground strafing, and navigational sorties. While the emphasis is on pure flying and aircraft handling, much time is devoted to briefing, de-briefing and the assessment of results in connection with the armament sorties. The squadron's second task is to provide operational jet conversion.

A comprehensive ground-school syllabus, designed to give pilots a thorough knowledge of their aircraft and its tactical uses, includes lectures on high-speed flight, high-level navigation, engineering, action information organization, communications, armament, tactics and Army support. In addition, there is a well-equipped air engineering ground school, where pilots are taught the constructional and operational details of the Sea Hawk and the Nene engine.

This, briefly, is an outline of the progress of Fleet Air Arm pilots, observers and telegraphists as individuals from entry until the time they may be considered fully trained. At this stage they are ready to join squadrons and continue their training further—not as a pilot or an observer or a telegraphist, but as a crew or a section of a squadron, working up from a miscellaneous collection of specialists into an effective operational unit.

Up to the present time, squadrons have fitted into the framework of the "carrier air group cycle"—a time scale aligned with

Gannet flight simulator used at R.N. air station, Eglinton.

Assessing cine interceptions at air fighter school, Lossiemouth.

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the commissioning or re-commissioning date of a particular carrier. A five-months shore-based work-up period for the squadrons is involved: at the beginning of this period the squadrons intended for this carrier form; at the end of the period they embark in the ship. On completion of the ship's tour, the squadrons disembark, and disband, after a life of about 14 months.

To be more correct, this was the cycle into which the squadrons *were intended* to fit. Delays in carrier-availability dates, and the emergency measures during the Suez operations, have resulted in changes to this regular pattern. But the sequence of squadron formation, work-up, and embarkation remains the same.

For the future, the new permanent-squadron system (just announced) will provide a greater flexibility in matching squadrons with carrier requirements. Front-line squadrons will no longer disband after a relatively short life; they will remain in existence and their personnel will serve tours of duty of about 18 months.

Examples of fighter and anti-submarine squadrons engaged in the work-up phase at present are 803 and 806 Squadrons (Sea Hawks) at Lossiemouth, and 814 and 820 Squadrons (Gannets) at Culdrose and Eglinton. The two Sea Hawk squadrons are working-up in parallel, with the main emphasis throughout the five-month period being applied weapons-training. Pilots are expected to fly a total of 120 hours during this time. While both squadrons devote a certain amount of time to each of the Hawk's possible rôles (such as air-to-air and air-to-ground gunnery, day and night bombing, rocketing), 803 is equipped with FGA 6s and is specializing in ground attack; while the "Ace of Diamonds" insignia of 806 (the first Hawk squadron to be formed—in 1953) is now painted on their FB5s, whose main task is interception.

Towards the end of the work-up period, fighter and strike squadrons undergo a period of "flaps"—front-line armament practice. This involves a particularly intensive programme of weapons flying, under the guidance of instructors from the Advanced Weapons Training Flight at Lossiemouth. Normally a squadron would carry out this work at Lossie, but it is not always so. At present, for example, "flaps" are being carried out in addition by squadrons at Brawdy, South Wales. The main object of these intensive training periods is to produce a high standard in armament work and to ensure that all squadrons think and act along the same lines.

In each of these four squadrons, the majority of pilots (and, in the Gannets, complete crews) were inexperienced in front-line squadron flying before joining the squadron. This is typical of newly formed squadrons, where in many cases the commanding officer, senior pilot and air-warfare instructor (the three flight leaders) might be the only experienced pilots. Here it should be added that, in anti-submarine and early-warning squadrons, the commanding officer is not necessarily a pilot; in a number of cases such squadrons are led by observers.

Squadrons 814 and 820 are equipped with Gannet AS.4s and AS.1s respectively. The training carried out by the two squadrons follows the same broad pattern, and includes crew training, anti-submarine bombing, minelaying, depth-charge dropping, MADDLs (mirror airfield dummy deck landings), and joint anti-submarine exercises by day and night. The two squadrons are destined for different carriers and are at different stages of their work-up—indeed, 820 has now completed its formal work-up programme.

Other functions of the Advanced Weapons Training Flight include the training of fighter air-warfare instructors (one such weapons specialist is a pilot member of each squadron); of C.Os designate, who receive a modified form of the A.W.I.'s nine-week course with the accent on leadership in the air and the standardization of operational techniques; and of Naval gunnery officers, who are given experience of most forms of fighter attack. Air-warfare instructors (A/S) are trained at Eglinton.

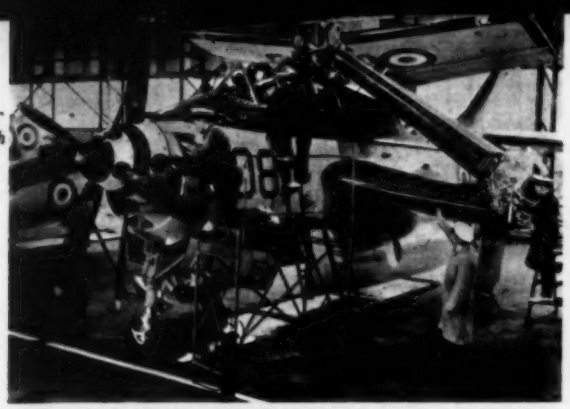
Turning from Sea Hawks and Gannets to the remaining aircraft types in front-line operational service, we may consider in turn Sea Venom all-weather fighters, Wyvern strike aircraft, Skyraider early-warning aircraft, and helicopters.

Pilots and observers destined for Sea Venom FAW aircraft receive their introduction to air interception equipment and techniques at the R.A.F. All-Weather Operational Conversion Unit at North Luffenham. Here pilots take a twelve-week course (two weeks' ground-school, eight weeks' interception training and two weeks' gunnery), flying in Meteor 7s for checks and standardization and Meteor 12s and 14s for the interceptions. Before going to North Luffenham, pilots would have converted on to the Meteor at the Navy's jet conversion unit, operated by Airwork, Ltd., at St. Davids, near Brawdy.

After familiarization with the air interception radar equipment, observers join up with their pilots during the second phase of training, and from that time on carry out ground-controlled interception exercises as a crew. By the end of the course the student crew is able to follow and intercept an evading target at night.

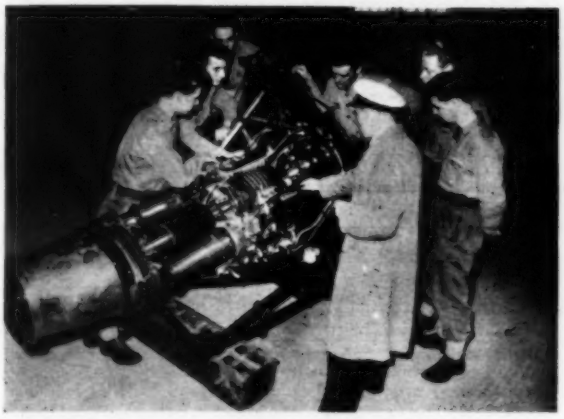
From North Luffenham, conversion on to Sea Venoms is the next step for the Naval all-weather fighter crews. This takes place at Yeovilton—or, during the runway alterations at present under way at this station, at nearby Merryfield. Here conversion is the

Observers fly in Sea Princes during training at Culdrose.



Arbroath is the "Alma mater" of the Fleet Air Arm's apprentices, some of whom are here working on a Gannet.

R.N.A.S. Brawdy, South Wales: the new chief and petty officers' messes, part of a large, new building scheme.



Air-mechanic training for leading rates takes place at Yeovilton. Here, a sectioned Mamba is studied.

Maintenance work by Wrens on Sea Vampire T.22 of the Junior Officers' Air Course at Lee-on-Solent.

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task of 766 Squadron, the all-weather fighter pool. Ground-controlled interceptions are practised, using the squadron's Sea Venom FAW 21s, together with a limited amount of further navigation and armament training, and training is continued until the crews join a front-line squadron.

Two operational Venom squadrons were also in residence at Merryfield when *Flight* visited the station recently. These, too, were at different stages of the work-up phase: 891, with Sea Venom FAW 21s, was nearing the end of its work-up, while 894, with the higher-thrust Mk 22s, had only recently begun. Each squadron had its own direction officer, and air interceptions (which logically take up the greater part of the work-up periods of these squadrons) were directed from a nearby R.A.F. G.C.I. station.

Since the Suez operations, when Venoms forsook their high-altitude rôle for ground-attack work, this latter type of operation has been included in the normal training of Venom squadrons. Thus low-altitude attacks with guns, rockets and bombs, directed either by Army ground units or by Skyraiders, have been added to the work-up syllabus.

Pilot conversion onto Wyvern strike aircraft takes place at Ford, where all Wyvern squadrons to date have worked-up. The unit responsible for this conversion is 764 Squadron, whose official title is the Naval Jet Pilot Pool. Vampire T.22s, Sea Hawks and Wyverns make up the squadron's aircraft fleet. In addition to Wyvern conversions, the squadron provides jet refresher or continuation training for pilots of varied levels of experience.

The Navy's Skyraider AEW Mk 1 aircraft belong to a unique and almost self-contained squadron, No. 849, with Culdrose as its parent station. The squadron comprises a Headquarters Flight, permanently based at Culdrose, and four operational Flights—A, B, C and D—which operate as separate units in carriers.

The Skyraiders carry extremely powerful radar (which weighs about a ton) and their foremost task is early warning of attack by low-flying aircraft. The machine, which has a crew of a pilot and two observers, is thus capable of extending the range of a carrier's own radar. Combat air patrols may be controlled from the Skyraider, or by the carrier directors by means of a radar relay. Other possible tasks include strike direction and submarine detection.

Training of pilots and observers in the operation of the Skyraiders and their equipment is carried out by the headquarters flight at Culdrose. While the whole object of the aircraft is to act as a radar platform, with the major responsibility resting with the observer who operates the radar equipment, skilled piloting can do much to assist in increasing the equipment's effectiveness.

Lee-on-Solent, long-established as the headquarters of the Fleet Air Arm, has among its varied units No. 705 Squadron, which is responsible for the conversion training of Naval pilots on to helicopters. Equipped with Hillers, Dragonflies and Whirlwinds, the unit has certain other functions, including search and rescue, and special trials. During our visit to the squadron last month, two Whirlwinds were practising the towing of surface vessels in connection with trials of helicopters for minesweeping duties. The problems of helicopter night-flying are being actively studied, and typical night-flying exercises taking place during our visit included straight conversion training (a part of the normal course), autorotative landings, and trials of night rescue techniques.

Each Naval air station and carrier has a resident helicopter flight, equipped with Dragonflies or Whirlwinds. One of these units, based at Lossiemouth, was awarded the Boyd Trophy for 1956 for the outstanding rescue of 41 men from the *Dovrefjell*. As well as search and rescue and general communications work, certain stations have additional tasks for their helicopters, such as firing-range communications and (at Eglinton) anti-I.R.A. patrols.

The Fleet Air Arm's only front-line helicopter squadron at present is No. 845 which, employing Whirlwind helicopters fitted with "dipping asdic" or "dunking sonar" gear (British and U.S. terms for the same equipment), are engaged on anti-submarine duties. As no fixed-wing replacement for the Gannet is planned, the experience being built-up by 845 will obviously preface an extension of the use of helicopters in this rôle.

These squadrons and air stations together provide the facilities for the Service's flying training programme. Flag Officer Flying Training has his headquarters at R.N.A.S. Yeovilton, and is responsible for the air stations at Yeovilton, Culdrose, Lossiemouth, Eglinton, Ford and Brawdy.

Ground Training.—Those ratings responsible for the maintenance and servicing of Fleet Air Arm aircraft and equipment, and for the many other "ground" duties (such as aircraft handlers on board carriers, crash and fire crews, meteorologists) which so effectively support the efforts of the aircrew, fall broadly into four categories. The most skilled is the artificer branch; the remaining three are those comprising naval air mechanics, electrical mechanics (air) and naval airmen respectively. Entry into each of these four grades is possible at "junior" or apprentice level, and at adult level.

The main form of entry into the artificer grade is by a five-year

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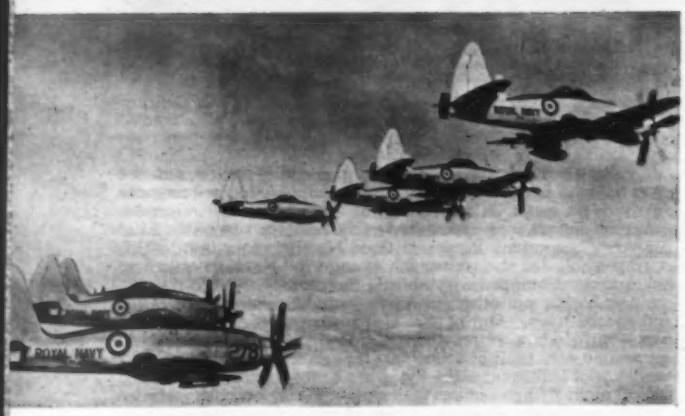
Left, Sea Venoms of 894 Squadron, pictured during work-up period.

Below, night scene at Merryfield: Sea Venoms of 891 Squadron.



Above, Wyvern strike aircraft of 813 Squadron.

Above, Whirlwind night-flying at Lee; note minesweeping gear.

Below, Skyraiders of 849 over the Cornish coast.

apprenticeship, beginning at the age of 15-17. After 16 months' general training at H.M.S. *Fisgard* (a shore establishment near Devonport), those destined for the Fleet Air Arm complete the first four years of their apprenticeship at either R.N.A.S. Arbroath (aircraft artificers) or H.M.S. *Collingwood*, Fareham, and H.M.S. *Ariel*, Worthy Down (electrical and radio).

At Arbroath, the aircraft artificers receive an essentially well-balanced course of training. In addition to instruction in airframes, engines, ordnance, ground-school subjects and general workshop techniques and practice (including machining and sheet-metal work), outdoor games and initiative-training camps in the Scottish mountains are included. Among the station's spare-time activities are those of a ski club, mountaineering club and mountain rescue unit.

Passing out from Arbroath as aircraft artificers 5th class (equivalent to a leading rate), apprentices complete their final year of training with a squadron or at an air station, and from that time on gain promotion according to length of service up to A.A.3, A.A.2, A.A.1 and chief A.A. or, if suitable, to commissioned rank.

Direct civilian entry into the aircraft artificer category, by-passing Fisgard and Arbroath, is possible for those who have completed a four-year or five-year apprenticeship in the aircraft industry. Such entrants join as probationary A.A.5s or A.A.4s and sign on for nine years (apprentice entrants join for 12 years from the age of 18).

In parallel with the stream of aircraft apprentices is a similar flow comprising the electrical artificers (air) and radio electrical artificers (air). Leaving Fisgard, apprentices in these categories receive 20 months' basic training at H.M.S. *Collingwood*, Fareham, followed by 12 months on air equipment at H.M.S. *Ariel*, Worthy Down. Here again, direct entry is possible, in which case entrants receive only 35 weeks' (electrical) or 44 weeks' (radio) technical training at Worthy Down.

The other three "ground" categories are naval airmen, air mechanics and electrical mechanics (air). Entry into these trades is either at 17½-28 years of age, or under the new "junior entry" scheme (which has replaced the more-limited "seaman boy entry") at 15-17½. In both cases recruits enter for a long-service engagement of nine years from the age of 18.

Junior ratings begin their Naval career in either H.M.S. *Ganges*, near Ipswich, or H.M.S. *St. Vincent*, Gosport. A course of about one year's duration is given, the first half of which is general and the second semi-technical. From these two establishments, the junior mechanics and junior airmen go to Bramcote or Worthy Down for the further training described below.

Direct (adult) entrants for naval airmen and naval air mechanic duties join at Lee-on-Solent, where a medical examination is given and other initial formalities completed, but continue after one or two days to R.N.A.S. Bramcote, near Nuneaton, for their new-entry training lasting six weeks. On completion of this first part of their course, they are joined by the juniors from *Ganges* (and by W.R.N.S. air mechanics), and take a further six-week course devoted to airmanship.

Examinations then complete the basic side of Bramcote's training, after which the stream divides into seven specialist channels. Naval airmen leave Bramcote for training as aircraft handlers (Lee), safety-equipment ratings (Lee), photographers (Ford) or meteorological observers (Kete, South Wales); while the air mechanics remain for 15-week courses in airframes, engines or ordnance.

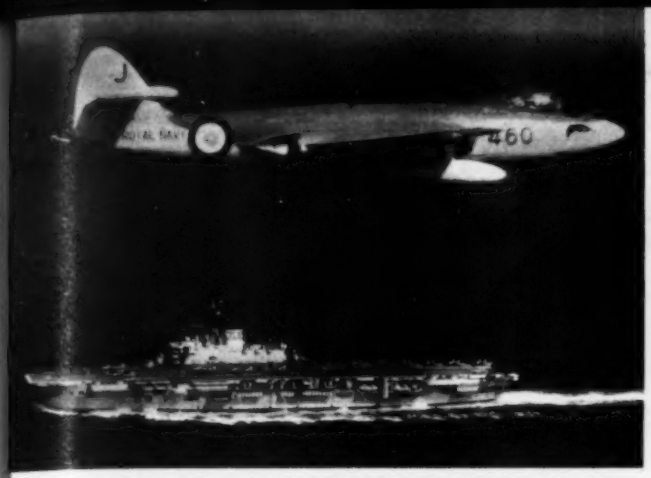
The School of Aircraft Handling at Lee-on-Solent provides a basic five-week course, during which the principles of deck handling are taught on the school's dummy angled deck, complete with island, flying control position and deck loudspeaker system. The other main aspect of the school's work is crash rescue and fire-fighting, taught at Gosport. Selected aircraft handlers are given a further nine weeks' training as aircraft directors.

Safety equipment ratings receive their training, a twelve-week course, at Seafield Park, near Gosport; while naval airmen (phot.) attend the well-equipped R.N. School of Photography at R.N.A.S. Ford for 27 weeks. Meteorological training (eight weeks) is given at the R.N. School of Meteorology, which is located at Kete. As mentioned, air mechanics receive trade instruction at Bramcote.

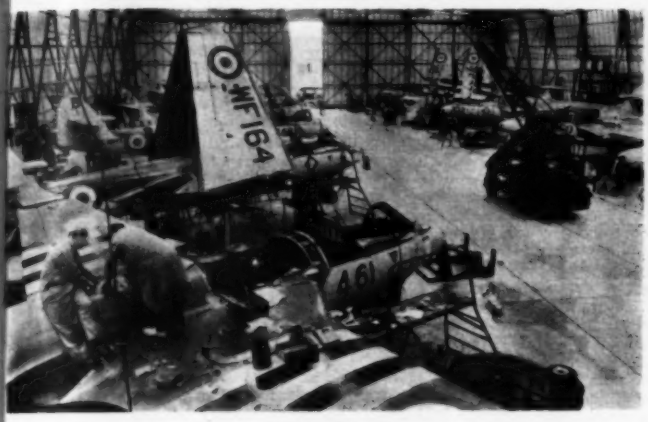
Again there is a parallel stream containing electrical and radio specialists. "Direct entrants" from civilian life at 17½-28 join H.M.S. *Collingwood*, Fareham, where, together with non-aviation electrical recruits, they undergo six weeks' new-entry training. At the end of this time they continue to H.M.S. *Ariel*, Worthy Down, where they are joined by the juniors from *St. Vincent*. Their first courses at *Ariel* take up 14 weeks (electrical) or 22 weeks (radio).

After these various courses of training, and after the appropriate qualifying period, the above-mentioned men will be rated as naval airmen 1st class, naval air mechanics 1st class, electrical mechanics (air) 1st class, or radio electrical mechanics (air) 1st class. The next step in their Service career would be to gain experience in squadrons and air stations.

Promotion to leading rate requires both a specified period of experience and, in most cases, a further course of technical train-



Hawk and Eagle: 897 Squadron Sea Hawk flies over "Eagle."



Above, Sea Hawks of 806 Squadron, working up at Lossiemouth with 803, formate along the Scottish coast.

Above, Sea Vampires of 736 Squadron, air fighter school, Lossiemouth. Left, attention to Sea Hawks in a hangar at Fleetlands Aircraft Yard.

ing. For air mechanics this course, of 13 weeks' duration, is held at Yeovilton, while electrical and radio specialists return to *Ariel* for 25 and 38 weeks respectively.

The stage from leading rate to petty-officer rate is similar, and involves further courses in each of the specializations mentioned except meteorology. Air-mechanic training for this grade (here petty officers are trained to air-fitter level) takes place at Arbroath and lasts 26 weeks. Radio and electrical courses for petty officers, taking some 18 weeks, are again at Worthy Down. For promotion to C.P.O. a time period is specified.

Additional opportunities are interspersed within this broad framework. The best air, electrical and radio mechanics are selected for commissioned rank or for further training to become aircraft mechanicians, and petty officer airmen are also eligible for commissions. Mechanician's courses last about 18 months—at Arbroath and Worthy Down as appropriate—and are designed to be equivalent to full apprenticeships.

Some 30 per cent of the Navy's engineer officers specialize in air engineering (as opposed to marine or ordnance engineering) and of these about half are selected to become pilots. Those who receive their wings will clearly have a particularly comprehensive training behind them for, in addition to the flying course, they will have received Dartmouth training, a 2½-year basic engineering course at the R.N. Engineering College, Manadon, general sea experience and a two-year air engineering course. Air engineers who do not become pilots serve on squadrons, carriers or air stations, or in research and development units.

While all engineer officers specialize in air, marine or ordnance work, general-list electrical officers (who, as air electrical officers, similarly serve with flying units, ships, stations or in research and development) are not specialists; they need to be competent in the whole range of Naval electrical equipment. They receive their training at Dartmouth; at Cambridge or another university; with industrial firms; at *Collingwood* and (for air-equipment courses) at *Ariel*. Special-duty list officers promoted from the lower deck, however, do retain their air specialization.

In this way are provided the male "ground" specialists of the Fleet Air Arm. To complete the picture, we may take a look at the Wrens and at their particular contribution to naval aviation.

Of the various jobs open to members of the W.R.N.S., five are exclusively connected with the Navy's flying operations. Wrens can become air mechanics (airframe or engines), radio (air) ratings —equivalent to radio electrical mechanics (air), range assessors, air stores ratings and meteorological observers. Specialist training in these subjects is given (at the appropriate units such as Bramcote, Worthy Down and Kete) on completion of the Wren's new-entry course of four weeks at H.M.S. *Dauntless*, a shore establishment near Reading. In general, a higher standard of education is required for these air categories than for most other jobs open to Wrens; and a large number of Wrens are commissioned in the radio (air) and meteorological trades, as well as in safety-equipment work.

Other Wren categories closely (but not exclusively) connected with the air side are those of radar plotter, signals and telegraphist. In the control towers of most naval air stations, for instance, R/T

[*contd. overleaf*

Above, Sea Balliols of the Junior Officers' Air Course. Below, main dispersal area, Royal Naval Air Station Hal Far, Malta.

Aircraft handlers receive deck-handling training on the dummy deck of the School of Aircraft Handling at Lee.

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contact with aircraft and ships on many channels is maintained by Wren operators.

Aircraft Supply.—The entire efforts of the men and women whose training has been described are finally devoted to operating, maintaining and getting the best results from the Navy's aircraft. The system which allocates, provides, stores and repairs these machines, and which keeps them in an up-to-date condition, is thus an extremely important one. In charge of this system is the Flag Officer Reserve Aircraft, who is the Naval Air Equipment Authority (U.K.) and who has his headquarters at Arbroath.

From the Arbroath headquarters is co-ordinated the work of the three Aircraft Repair Yards (at Fleetlands, near Lee-on-Solent; Donibristle, Scotland; and Belfast), and the three aircraft holding stations (Abbotsinch, Anthorn and Stretton, near Warrington) and two aircraft holding sections (R.N.A.S. Lossiemouth and R.N.A.S. Lee-on-Solent), which are the operating units of the F.O.R.A. command. The rôle of these stations can best be seen, firstly, by tracing the movements of a new aeroplane from factory to squadron, and then by considering the repair, modification and major overhaul of used aircraft.

From the aircraft factory, a new Naval machine goes first to a holding station. Venoms from de Havillands at Chester, for instance, are flown to nearby Stretton. Here they are check-flown for acceptance by the Navy; modifications are incorporated; guns are installed, aligned and tested; and radar equipment is fitted. This takes from one to two weeks, after which the machine is test-flown and the radar is air-checked. The process is one of converting the basic aircraft to full operational standard, and the machine is then ready for its delivery flight to squadron or air station.

Depending on the required delivery date (planned at F.O.R.A. headquarters), the aircraft would either be delivered immediately or placed in a serviceable-aircraft pool until required. If not delivered within six weeks, it would be transferred to "long-term storage," normally in a hangar but occasionally embalmed and in the open. After this storage and before delivery, the machine would be "de-preserved" (as the Navy expresses it), and equipped, checked and test-flown in the same manner as when first received.

The same procedure is involved for used aircraft which have been completely re-conditioned by the naval repair organization (the aircraft yards) or by civilian firms. A further source of aircraft for holding-station attention consists of those needing some modernization or refurbishing, but not complete reconditioning; these would be flown to the holding station direct from the squadrons and stations concerned.

No single holding station deals with all aircraft types in service: the broad allocation is for day fighters to go through Abbotsinch; anti-submarine machines through Anthorn; and all-weather fighters and strike aircraft through Stretton. The only engine holding unit (all types) is at Burscough, attached to Stretton. Also at Stretton is the Mobile Aircraft Repair Unit, which travels to carry out on-the-spot repairs at stations where necessary.

Although a limited amount of maintenance work is carried out at the holding units, it is in the three aircraft yards that the main overhaul and repair work is carried out. As the title implies, these units are comparable in function to the R.N. dockyards which perform overhaul and repair work on ships of the Fleet. Again, each yard specializes; Fleetlands is concerned with Sea Hawks and (for modernization only) Wyverns; Donibristle with Gannets and helicopters; and Belfast with Venoms and Vampires. On the engines side, Belfast has been responsible for the last of the piston engines; Fleetlands looks after turbojets; and Donibristle has the turboprop Double Mamba.

Flight chose to visit Fleetlands as a typical aircraft yard. Here over 1,000 civilian workers are employed, over half of whom are skilled craftsmen. Modern industrial techniques are in evidence, together with a progressive planning department. The type of work carried out at Fleetlands has changed in two main directions over the past few years. Firstly, the old periodic major-reconditioning scheme for aircraft is no longer in being. Secondly, the amount of aircraft repair work needed has dropped markedly since the introduction of improved carrier-flying techniques. "Modernization" work has accordingly increased; the latest modifications are incorporated when the aircraft come in for main checks. Of the total effort during last year, 30 per cent was directed to repair work; 25 per cent to modernization; 20 per cent to component repair; ten per cent to Nene and Ghost overhaul; ten per cent to component manufacture and five per cent to miscellaneous jobs for Home Air Command.

The broad pattern of the supply of Naval air equipment in this country, then, is from manufacturer to holding unit to operational user. From the user, as required, to aircraft yard, to holding unit, to the user again.

While the path followed is straightforward, the integration of requirements, facilities, priorities and the time element is extremely complex. This is the responsibility of headquarters at Arbroath, and the organization there for keeping accurate records, for displaying information and for decision-making is efficiently self-contained.

The nerve-centre is the operations room, its walls covered with large, clear visual-records boards. Each aircraft in the Fleet Air Arm is represented by a card which, inserted in the appropriate board, indicates where it is and its state of modification. On the holding-unit boards the progress of aircraft through the various stages can be followed, while on other boards the aircraft are grouped by squadrons. Information for forward planning is also displayed.

Allotment—some 5,500 aircraft and engines movements were made during 1956—is a tricky business. Estimated movements for each holding unit are prepared for four-month periods in advance. These estimates are based on factors such as Admiralty and squadron requirements, new-aircraft and R.N.A.Y. production, replacement of over-age aircraft and calculated wastage.

Responsible for the four-monthly forecast is the planning section, in conjunction with the operations room. The third main section is that devoted to records, in which the complete Service history of all aircraft and engines is recorded, by means of a quick-reference card filing system. Census and accident signals from carriers and stations are typical of the incoming information

At Gosport, crash rescue and fire-fighting practice (using dry-powder extinguishers) is part of the S.A.H. syllabus.

Southern Fixer Service at Yeovilton, where simultaneous CR/DF bearings provide immediate position-fixes for aircraft.

which is used to keep the records up-to-date; in turn statistical data are sent on to the Admiralty and other authorities.

A large number of aircraft movements, clearly, are involved between holding units, aircraft yards, and various air stations. Most of the ferry flights are carried out by civilian pilots employed by Shorts and based at Rochester, who have ferried over 9,000 aircraft since November 1950. As the U.K. equipment authority supplies the corresponding overseas authorities (at Malta and Singapore), several hundred overseas flights have been included. For the transport of damaged aircraft, the Queen Mary trailers of the two Naval Air Transport Salvage Units, at Lossiemouth and Worthy Down, are employed.

Other Units.—The three streams of effort described above, directed towards providing the men and providing the aircraft, are in effect the three prongs of the Home Air Command trident. Also playing an essential part in the work of the Fleet Air Arm at home are a number of units which, although in most cases based on stations having a primary task of flying training, ground training or reserve aircraft, are self-contained units with responsibility elsewhere.

At Lee-on-Solent, the headquarters of the Flag Officer Air (Home) contains the drafting office for all Fleet Air Arm ratings. While Lee remains their "depot," the old R.N. Barracks concept has here been abolished and direct drafting from one station to another is employed.

Specialist units at Lee include the Naval Air Maintenance Development Unit, the Naval Air Radio Installation Unit and the Accident Investigation Unit. N.A.M.D.U. is administered by the Director of Aircraft Maintenance and Repair, Admiralty, and provides field working parties in connection with maintenance aspects of new and current aircraft types. Among its functions are servicing appraisals of new aircraft types, the study and revision of servicing methods, the analysis of unserviceability information, and the initial training and subsequent administration of special maintenance parties.

The Naval Air Radio Installation Unit undertakes the design and construction of aircraft electronic installations for such purposes as Service trials, Fleet and squadron exercises, and equipment evaluation; and also that of mobile air radio and radar workshops. Responsible to the Flag Officer Air (Home), the unit is at present working on a number of secret projects concealed under the general phrase "trial installations of various H.F., V.H.F., radar, radio-compass and navigational aid equipments in various types of aeroplanes and helicopters."

Another self-contained group with headquarters at Lee is the Aircraft Accident Investigation Unit, which sends out investigating teams for "on the spot" analyses of accidents. The prevention of accidents, as well as their investigation, is the concern of this unit, which works closely with the Naval Air Materials Laboratory located at Fleetlands Aircraft Yard. This laboratory comprises a metallurgy section and a chemistry section, and its personnel also travel widely in the course of their important work.

Another link between Fleetlands and Lee is that all test-flying of aircraft turned out by the Yard is performed, by Fleetlands test pilots, from the airfield at Lee.

Also located in the Lee-Fleetlands-Gosport area is Seafield Park, home of the Safety Equipment and Survival Training School, the R.N. Air Medical School, the Central Air Medical Board and the Naval Aircrew Advisory Board. The Air Medical School is concerned with a variety of current and future aeromedical problems. For many years responsible for teaching both doctors and aircrew, the school is at present adding to the research side of its activities. Its equipment includes two high-altitude decompression chambers, an ejector-seat rig, and a new cold-water tank in which the effects of immersion on men and equipment can be studied. Liaison with the R.A.F. Institute of Aviation Medicine is maintained.

As a matter of incidental interest at the school we noted the following list of what the well-dressed Fleet Air Arm pilot will be wearing next season: String vest, air ventilated suit, thin drawers, thick drawers, g-suit, jersey, socks, shirt, flying overall or immersion suit, pressure waistcoat, lifejacket and beacon equipment, inner helmet, protective helmet and vizor, oxygen mask, cape leather gloves, parachute assembly and emergency oxygen set, and dinghy pack. (No. 898 Squadron's bowler hats are apparently worn only for special occasions.)

Lee's flying task includes the operations of two units not mentioned so far: the Southern Communications Squadron and the Junior Officers' Air Course. The aircraft of both come under 781 Squadron, although the two units operate separately.

A twice-weekly scheduled service with Sea Devons between the Naval air stations in the southern half of the country is the main task of the Southern Communications Squadron. This facility—known familiarly as the "Clipper Service"—connects at Anthorn with a similar northern schedule operated for the Navy by Airwork at Donibristle. In addition, the squadron is available for V.I.P. and compassionate communications work, ambulance duties and freighting.

Donald Duck—wearing sub-lieutenant's stripes and a bone-dome—features in the insignia of the Sea Balliols, Vampires and Princes of J.O.A.C., the Junior Officers' Air Course. The junior officers referred to are those who, having completed two years at sea as midshipmen, are rounding-off their initial training with a series of technical courses in the Portsmouth area. At Lee they spend four weeks attending the air course.

Ten hours' flying—including rocket firing, strikes on warships and deck landings—and a comprehensive ground-school syllabus is involved. Although many of the on-course sub-lieutenants will later train as pilots and observers, no additional training is given at this stage. The whole purpose is to impart a basic knowledge of aviation to all Naval officers—a task which the J.O.A.C. team find worthwhile and, incidentally, enjoyable.

At Brawdy, Pembrokeshire, 727 Squadron are engaged in a similar task, directing the impact of the Fleet Air Arm (sometimes only too well, as the opening paragraph of this article shows) on to even younger and presumably more-impressionable minds. The pupils here are Dartmouth naval cadets who, as part of their three months' sea time with the Dartmouth training squadron, fly to Brawdy for a ten-day air course. This scheme began with the introduction in January 1956 of a new system of officer training in the Navy; not the least of its advantages is the fact that cadets are taught on an active airfield which usually has at least two front-line squadrons in residence.

Ahead of the R.A.F. in the provision of an automatic navigational fixer service for its aircraft, the Fleet Air Arm possesses control stations at Yeovilton and Abbotsinch. At each of these stations, simultaneous CR/DF cross-bearings from up to five separate stations are projected on to a ground-glass map in the control room on receipt of an aircraft transmission, giving an immediate fix.

What might be called second-line squadrons with front-line applications are Nos. 745 and 751, with headquarters at R.N.A.S. Eglinton and R.A.F. Watton, Norfolk, respectively. Their task involves trials and exercises in "radio warfare" (the detection and jamming of enemy radar and radio stations) and all that *Flight* may say about them now is that in the not-too-distant future their crews should have something rather faster than the old-bottle Avengers into which so many new-wine black boxes have been poured.

No. 700 Squadron at Ford is known as the Trials and Fleet Requirements Unit. Its aircraft are in practice maids-of-all-work, dealing (on the trials side) with the effect of the introduction of new equipment into all types of aircraft and (in the F.R.U. rôle) with target-drogue towing, radar calibration work and ship photography. A civilian section of the F.R.U., operated by Airwork and based at Hurn, is equipped with Sea Hawks, Attackers and Sea Furies; while the squadron at Ford has a variety of types, including Sea Hawks, Sea Venom, Wyvern, Gannet, Seamew and Sea Vampire T.22.

An unexpected sight, for a visitor, is that of Army personnel aboard carriers and at Naval air stations. These officers and men belong to the Carrier-Borne Ground Liaison Sections, whose job is to ensure the effectiveness of Army-support operations (and in particular ground-directed attacks) by Naval aircraft. With a headquarters representative attached to the staff of F.O. Air (Home) at Lee, there are C.B.G.L. training units at Lossiemouth and Brawdy and operational sections on board each carrier.

These, then, are the many and varied units which make up the strength of Home Air Command. Individually each has its own specialist task; together, they achieve their real and unique purpose. They produce front-line squadrons with trained aircrew, trained groundcrew and operational equipment. They produce trained specialists and new equipment for squadron, ship or air station.

The squadrons thus formed will spend their operational lives on board the Fleet's carriers or at Naval air stations at home or abroad (at Hal Far, Malta, and Sembawang, Singapore). And these squadrons will be supported at all stages and at all levels, not only by the Home Air Command stations described in this article but, for instance, by the Ministry of Supply units at various other establishments. These include the Naval sections in the handling squadron at Boscombe Down and in the Telecommunications Research Establishment at Defford, and the Naval aircraft department at R.A.E., Bedford. Also in close touch with the requirements of naval aircraft are the Naval Construction Department and the Engineer-in-Chief's Department, both with headquarters at Bath, whose staffs are concerned with the design of all ships, including carriers and their launching and arresting equipment.

The framework we have endeavoured to sketch is wide.

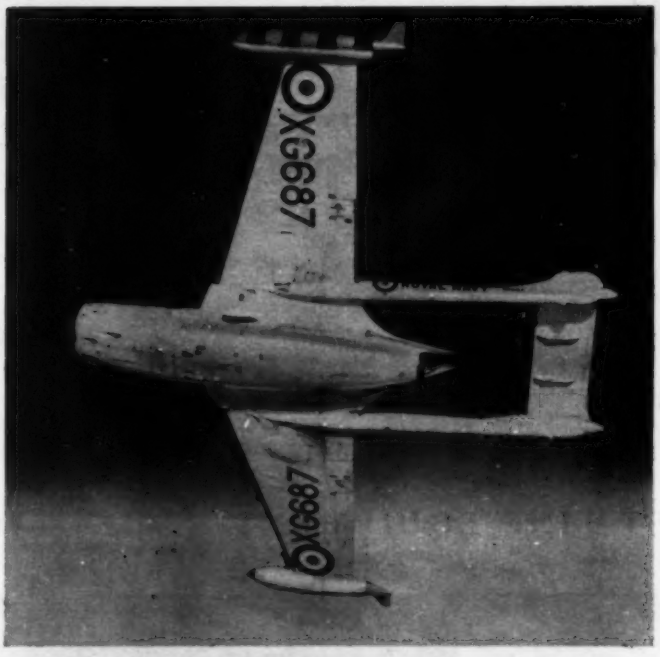
Having developed gradually from a small section of the Navy, to an integral part of it, then to its main core, the Fleet Air Arm receives a unique loyalty from its men and women. This loyalty is more than a sense of belonging, and more than the loyalty to one's own ship which is a familiar Naval characteristic. Perhaps it is a simple blend of heredity and environment, here translated as Naval tradition and the high standards demanded by the age of aviation.

K.T.O.

▲ **Hawker (A.W.A.) Sea Hawk.** Although the prototypes of this standard F.A.A. fighter/bomber were designed and built by Hawker Aircraft, Ltd., production and development has been entirely in the hands of Sir W. G. Armstrong Whitworth Aircraft, Ltd. All variants have been powered with the Rolls-Royce Nene centrifugal turbojet, and the latest versions—the F.B.5 and FGA.6—have a Nene of higher thrust than was fitted in earlier marks. Built-in gun armament is four 20 mm British Hispanos, and under-wing provision is made for bombs, rocket projectiles and/or auxiliary tanks. The Sea Hawk has been adopted by Holland and Germany.

FIRST-LINE EQUIPM

DEPICTED and briefly described in these pages are the types of aircraft, and the individual carriers, that now comprise the first-line force of the Fleet Air Arm, or that will soon be coming into service. Of the aircraft it must be added that a supersonic jet-propelled strike machine, the Blackburn N.A.39, is on order as a successor to the Westland Wyvern, and that an early-warning version of the Fairey Gannet (sub-type AEW.3) is in production for replacement of the American-built Skyraider. The Westland Wessex helicopter—a development of the American Sikorsky S-58, powered with a Napier Gazelle gas turbine—will succeed the Whirlwind. Anti-submarine operations will be its main task.



de Havilland Sea Venom. The Sea Venom is at present the F.A.A.'s standard night-and-all-weather fighter and, having provision for under-wing armament stores in addition to its built-in armament of four 20 mm guns, is a valuable ground-attack machine. It is a two-seater (pilot and observer—the latter operating the radar), and in the latest version, the FAW.22, both occupants have a Martin-Baker Mk 4 lightweight ejection seat. This model is also characterized by a more powerful mark of the de Havilland Ghost turbojet than was formerly installed. Sea Venoms are serving with the Royal Australian Navy.

IPMENT • Aircraft

de Havilland Sea Vixen. Formerly known by its type number D.H.110, this remarkable night-and-all-weather fighter (two Rolls-Royce Avon turbojets) is in quantity production and will soon begin to supplant the Sea Venom in F.A.A. squadrons. It is remarkable that, although of much later design, and having supersonic capabilities in the dive, the Sea Vixen retains the twin-boom layout of the earlier machine. Its power-control system is very highly developed and confers exceptional powers of manœuvre at very high speeds. As a fighter, the Sea Vixen is designed to be armed with air-to-air guided missiles, and in the attack rôle it can carry under-wing stores and/or auxiliary tanks.

Vickers-Supermarine Scimitar. Powered, like the Sea Vixen, with two Rolls-Royce Avons, the Scimitar (formerly N.113) is a single-seater. Intended to succeed the Sea Hawk, it will initially be armed with four 30 mm Aden guns, and it has been officially stated that it will carry the atomic bomb. Up to four auxiliary tanks can be carried as alternatives to external armament stores. Production Scimitars will have a blown-flap ("super-circulation") system, whereby high-pressure air is fed from the engine compressors to the top surfaces of the wing flaps. The onset of turbulence, and consequent loss of lift at high angles of attack and low speeds, is thereby delayed.

FIRST-LINE EQUIPMENT · Aircraft

Fairey Gannet. The Gannet is the standard fixed-wing anti-submarine aircraft of the F.A.A. and the latest version is the A.S.4. This is almost identical with the earlier A.S.1 but has a more powerful version of the Armstrong Siddeley Double Mamba turboprop. Although apparently single-engined, the Gannet is virtually twin-engined and can cruise with one half of the engine shut down. The crew numbers three and, in addition to radar, the aircraft carries anti-submarine weapons, sonobuoys, bombs, mines, air/sea-rescue containers, or marine markers. A training version (Gannet T.2) is in service. Gannets have also been adopted by the Royal Australian Navy and the West German Naval Air Arm.

Westland Wyvern. The Wyvern is unique in being the only turboprop-powered carrier-borne strike aircraft in service in the world. A massive single-seater, it is powered with an Armstrong Siddeley Python driving a Rotol eight-blade contra-rotating propeller, and the internal fuel capacity is 511 gallons. This can be augmented by two 90-gallon underwing tanks. Armament, additional to the four 20 mm guns, is a torpedo; or various combinations of bombs and rockets; or mines or depth charges. A speed of 380 m.p.h. is attained at 10,000ft, and maximum permissible diving speed is 550 m.p.h. The Wyvern is one of the very few propeller-driven aircraft to have an ejector-seat.

Westland Whirlwind. Several variants of the Whirlwind have been supplied to the Fleet Air Arm and the newest of these, the Mk 5, is powered with the Alvis Leonides Major engine. Whirlwinds have distinguished themselves in the rescue and plane-guard rôles; they are used extensively for communications and transport work and, on an experimental basis, for anti-submarine duties. A notable feature of the machine is the installation of the engine in the extreme nose, behind two clamshell doors. A simple operation enables it to be swivelled forwards and downwards for easy servicing.

FIRST-LINE EQUIPMENT

Carriers

ALL five operational carriers in the Royal Navy today—two "Fleets" (each of 46,000 tons) and three "Light Fleets" (each of 26,000 tons)—are fitted with the semi-angled deck and with the mirror-sight landing aid. Centaur *is at present undergoing an extensive modernization which will add the steam catapult to her equipment. Still under construction is* Hermes *(whose name was given to the light-fleet class), completion having been delayed to permit the installation of a fully angled deck, steam catapult and deck-edge lift.* Victorious, *a wartime fleet carrier, is also being extensively modernized at present.* Ocean *and* Theseus *normally constitute the Royal Navy's new-entry training squadron and, as such, do not form part of the Fleet Air Arm. They were brought into use, however, as helicopter assault carriers during the Suez operations.*

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Ark Royal. First commissioned in February 1955, *Ark Royal* is now engaged in her second commission with the Fleet. She is the most modern and best equipped of the Navy's carriers, possessing not only two steam catapults (as yet not fitted to any other British carrier) but also an advanced form of arrester gear. Three aircraft lifts are fitted, two of which are inboard (serving both hangar levels), and one on the port side, serving the upper hangar only. (*Flight's* impressions of flying operations from *Ark Royal* during recent exercises are given in the article *Ark's Day* which begins on page 383.) The Captain of *Ark Royal* is Captain F. H. E. Hopkins, D.S.O., D.S.C., and Commander (Air) is Commander D. G. Parker, D.S.O., D.S.C., A.F.C. The previous Captain of the ship was Capt. D. R. F. Cambell, D.S.C., now Director of Naval Air Warfare, Admiralty.

Eagle. Sister ship to *Ark Royal*, *Eagle* was originally commissioned in October 1951 and, after a refit and modernization during 1954-55, was recommissioned in March 1955. During most of the period of the Suez emergency last year *Eagle* was the flagship of Vice-Admiral M. L. Power, Flag Officer Aircraft Carriers, who was in command of the Anglo-French carrier group. The Captain of *Eagle* is Capt. M. Le Fanu and Commander (Air) is Cdr. P. C. Heath. ▼

H.M.S. "Bulwark" ▲ *H.M.S. "Centaur"* ▼

▼ *H.M.S. "Albion"*

FIRST-LINE EQUIPMENT · Carriers Albion, Bulwark and Centaur. *Centaur*, commissioned in September 1953, was the first of the *Hermes*-class carriers to join the Fleet, being followed in May and November 1954 by *Bulwark* and *Albion* respectively. For a period *Bulwark* acted as trials and training carrier; the requirement for such a ship has now lapsed, trials of new aircraft being carried out in the operational carriers as convenient.

An interesting specialist rôle for *Albion* in recent trials and exercises was that of an anti-submarine carrier, with a mixed bag of aeroplanes and helicopters aboard. These comprised the A/S Whirlwinds of 845 Squadron, Gannets of 824, Skyraiders of 849 "C" and Sea Venoms of 809. Prior to this, *Albion* and *Bulwark* were operating together with *Eagle* in the Mediterranean.

Captains and Commanders (Air) of *Albion* and *Bulwark* respectively are Capt. R. M. Smeeton, M.B.E., and Cdr. A. D. Corkhill, D.S.C.; and Capt. P. D. Gick, O.B.E., D.S.C., and Cdr. D. P. Law.

Joint operation, not individual action, is the keynote of effective carrier fighting. Here Sea Venoms and Sea Hawks are seen ranged in Eagle's deck park, with Bulwark and Albion in company, during exercises in the Mediterranean last year.

The Philosophy of Naval Air Warfare

By CAPTAIN D. R. F. CAMBELL, D.S.C., R.N.

CARRIER-BORNE aircraft are now accepted as the core of our sea power. What can be expected of them?

The United Kingdom, as in the past, depends for its survival on the freedom of the seas. Merchant shipping must travel unmolested and this country must import food and raw materials. If this flow stops, the life of this country stops, too. The Atlantic Ocean is our most important lifeline. This is no secret, and our enemies in two world wars have done their best to cut us off. Be in no doubt that a third world war will provide the same opportunity for the enemy and the same problem—greatly magnified—for us.

What are the threats which face our merchant ships and their Naval escorts in time of war? First, the submarine: greatly developed in recent years, capable of covering vast distances without ever coming to the surface. This serious menace is discussed later. Secondly, air attack; here we have the problem of detection and interception, for these aircraft must be attacked before they can release their weapons. Wait until the weapon has been released and it is too late! This problem is a study in itself and some of the factors affecting it are discussed below. Thirdly, the surface warship or raider. Operating singly or in groups, with their powerful guns they can pick off a convoy if they can get within range. Think for a moment of the problem confronting us and our allies if enemy submarines, aircraft and surface vessels operate in harmony and employ co-ordinated tactics. Carrier-borne aircraft must and will meet these threats and keep the lifeline open in conjunction with ships of the fleet and aircraft of the R.A.F.

The Aircraft Carrier.—The carrier must be looked upon as a mobile, self-supporting airfield complemented with men and aircraft capable of performing any of the functions demanded in air warfare. I want to emphasize the carrier's mobility, for it is in this respect it enjoys so much advantage over the airfield. It can place itself in the best position for operating aircraft; distances to be flown to the target can be reduced and aircraft can consequently be used to greater effect; more sorties per aircraft can be flown in a given time. Strategically located airfields overseas are less secure politically than they used to be, and in certain circumstances cannot be used at all. The Suez operation underlined these points.

The argument that aircraft carriers are more vulnerable than airfields cannot really be substantiated. Certainly all military installations are vulnerable in time of war, whether static or mobile. But, apart from mobility, the carrier has its own complex defence against all forms of attack.

THE author is at present Director of Naval Air Warfare, Admiralty. In 1951 he was responsible, together with Mr. L. Boddington, for the original suggestion of the angled-deck concept for carriers.

Many will say that the aircraft carrier can be sunk and consequently lost for ever. Let it be remembered, however, that modern weapons can "sink" an airfield one hundred feet or so and leave no trace of its existence.

The carrier is particularly suitable for "fire brigade" operations when limited military action is required to restore law and order. Ground forces, together with their light equipment and stores can quickly be deployed ashore by helicopter. This is quicker and more flexible than the employment of landing craft which have to approach slowly towards a defended beach.

Strike Aircraft and Tactics.—It is against this background that we can consider the general characteristics of the aircraft which form the complements of the carriers.

An ability to attack is the first requirement. Targets may be either ships afloat or installations ashore, but there is a considerable difference in the tactics of attacking a moving target at sea and a static target perhaps some hundreds of miles inland. In addition to being a good load carrier and accurate launcher of a selection of weapons, the Naval strike aircraft must be capable of attack at relatively long range. The combat radius of the strike aircraft dictates the launching position of the carrier; the greater the combat radius the greater the freedom the force commander will have when selecting carrier operating areas. Conversely, the more difficult will it be for the enemy to find him and, having found him, to retaliate. True, airborne radar has made tremendous strides in terms of sea area covered per sortie, and ships will not have the privacy they have enjoyed in the past; but their mobility contributes to their protection, and radio countermeasures can be used to confuse the enemy reconnaissance.

The strike aircraft must be capable of delivering atomic weapons as well as conventional rockets and bombs. In these sophisticated days there may be a feeling that anything less devastating than an atomic bomb will have no place in warfare. This is not so, and conventional weapons will continue to be used against certain types of target. The weapons system of a strike aircraft has become increasingly complex, with its radar, navigating equipment, homing aids, communications and radio countermeasures, as well as equipment for identification and weapons-sighting.

As readers will know, the Wyvern is the current strike aircraft and its eventual successor may be the N.A. 39. This project is a formidable problem for the design team because of the necessity for keeping down the weight and size of the aircraft to permit it to be operated from existing carriers.

Fighters will continue to need some strike capability so as to be able to support the Army and to attack ships. Naturally a complex strike system cannot be built into an aircraft designed for air defence without detracting from its performance in the primary rôle, but enough can be done to exploit the aircraft's considerable

THE PHILOSOPHY OF NAVAL AIR WARFARE...

potential in this respect. It is very doubtful indeed if the super-specialized fighter—e.g., the ship-to-air missile—could ever serve this dual purpose.

Meantime the Sea Hawk and Sea Venom have proved to be splendid aircraft in the strike rôle, and the capabilities of their successors, the Scimitar (N.113) and Vixen (D.H. 110), in this respect will be watched with some interest. The former will be in service this year.

Reconnaissance is an important component of striking operations often allowed to lapse in peace time. Unless it is known precisely where the target is and how effectively it has been dealt with by previous attacks, launching a strike or re-strike may be a waste of time and effort. There is a saying that "time spent on reconnaissance is seldom wasted" a dictum as true today as ever. Naval aircraft must, therefore, have this capability particularly in the photographic rôle.

What of ship-borne surface-to-surface guided missiles—the replacement for the carrier-borne strike aircraft? The American Regulus is the first fruit of this conception. Once again the importance of the seas is apparent because the launching platform is mobile, perhaps very difficult to locate and even more difficult to attack, particularly if it is submersible. How flexible would such a system be? Could it be used to attack a moving ship-target? Could it be used against targets ashore in a limited type of war or for close support of the Army? If it is used against shore targets how does one get to know where the target is and if, after launching, the target has been struck? Replacing the human piloted aircraft in the strike rôle is by no means the simple answer to a complicated problem. Against some specified targets the missile would be superb—against others useless. He would be a prophet indeed who accurately and convincingly forecast the state of the art in 2000 A.D.

Air Defence.—As mentioned above, there is always a risk of carrier task-forces and shipping on trade routes being subjected to air attack. Against what forms of air attack is the Royal Navy preparing to defend itself during the next ten years?

At the moment the maritime air threat is a near-sonic one and is represented by high-, medium- and low-flying bombers, scout and reconnaissance aircraft. However, we recognize that the time is fast approaching when defence will be needed against high-flying bombers capable of speeds up to and which may exceed Mach 2. The long-range ballistic rocket which has recently received much publicity in connection with the air defence of densely populated areas of the United Kingdom need hardly be considered in a maritime rôle against a moving target; but we find an almost equally severe threat—the stand-off weapon-carrying bomber which releases its weapon to "go it alone" when still many miles from the force which it is attacking. If such weapons are small, can fly fast and are capable of homing themselves with nuclear warheads on to their targets, they will represent a severe menace to ships and convoys.

Air Defence of the Fleet at the moment is based on front-gun fighter aircraft, with ships' anti-aircraft guns acting as long-stop; the next decade will witness the introduction of air-to-air and surface-to-air guided weapons. But it must be understood that fighter aircraft will still be required in our carriers to counter the enemy in case he finds it possible to attack from beyond or below the envelope of the Fleet's guided-weapon defences. Here, of course, we are considering the destruction of targets such as the stand-off weapon-carrying bomber or radar-equipped scouting aircraft, neither of which need ever approach within range of the force's guided weapons.

Later, the short- and long-range surface-to-air guided weapons can be expected to take a major share in air defence; but as has already been pointed out, fighter aircraft will continue to form a smaller but still essential part of the overall system.

When referring to the next generation we no longer speak of "a fighter aircraft" but rather of "a fighter weapons-system." Gone are the days when air defence could be established by mounting a gun in a fast, high-flying airframe. Future defence levels will depend on the correct functioning of a thousand and one components, from engines, to airborne radar, to guided missiles, to airborne communication systems all of which integrated together comprise the fighter weapons-system. Typifying this generation is the Vixen.

But what of the third generation, the fighters which will still be needed during the heyday of the surface-to-air guided weapons and which will be required to tackle really high-performance targets? What shape will these be, and how will the inherent limitations imposed on design by carrier-based operation be overcome? Here the solution may still be in the weapons-system fighter, the performance necessary to combat such targets being vested in the weapons system, the airborne radar and air-to-air missile, rather than in the parent aircraft. There is some reason to think that the generation-after-next of Fleet fighter pilots may perhaps find themselves flying "slow" fighter weapons-systems which could well be termed "fighter battleships."

The fighter or fighter weapons-system is only one component of a vast structure, the overall Fleet air defence system. Certainly the fighter constitutes an important part of that system in present-day operations; but, when discussing air defence, a further essential component of the system is the ship-borne radar.

The acquisition of early warning of an approaching enemy aircraft to ensure that the fighter is launched, together with the ability to direct the fighter accurately to an attacking position on its target, are two functions of surface radars, the importance of which cannot be overstressed. The Navy is fortunate in being about to introduce a radar set which will cope adequately with the latter function insofar as high and medium altitude targets are concerned.

The problem of detecting low-flying aircraft at a range sufficient to effect an interception is a difficult one. The solution is thought to lie in the provision of long endurance aircraft stationed around, but at some distance from, the fleet and fitted with suitable all-round-looking radar. The detections thus obtained could be passed electronically to the carriers. This system, known as airborne early warning, has been tried with much success.

It must be added that the results of recent full-scale air defence exercises have not been disappointing and have disproved the forebodings of the severest critics. These exercises were carried out with the present generation of Fleet fighters, the Sea Hawks and Sea Venoms; the position should be even better when the next generation of aircraft come into service.

Anti-submarine Defence.—The submarine threat appears to be an immense force of between 400 and 500 vessels. The factors and reasoning behind the decision to build such a large underwater Navy are not known. It may be that the major motive is to deny the Allies' freedom of action in those sea areas from which the allied naval atomic strikes could be launched. This suggestion is strengthened by the fact that the operating areas of the strike fleet are geographically limited to the radius of action of their strike aircraft. In effect, the enemy submarine fleet may well be their counter to the tactical mobility of carriers.

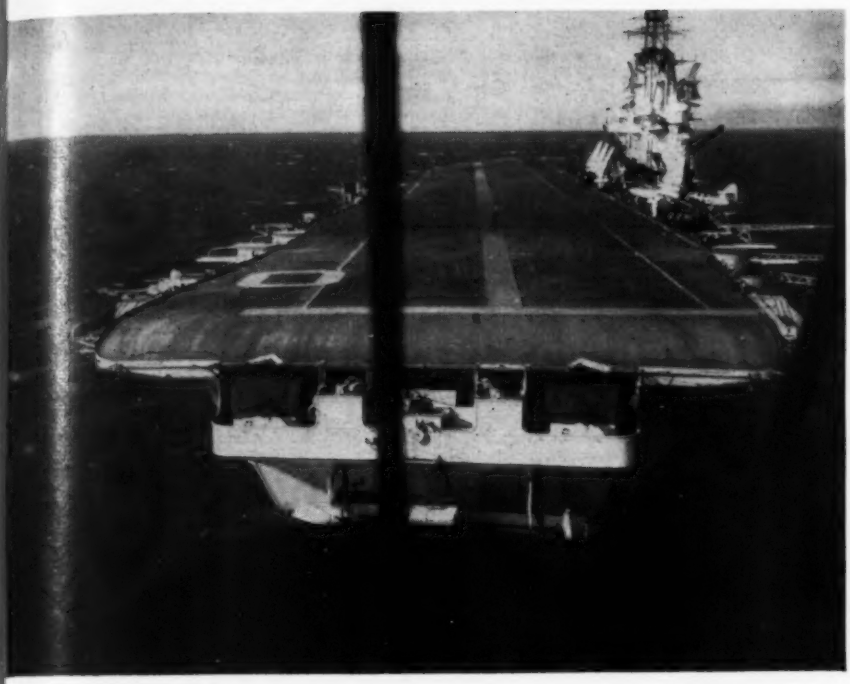
However, after the initial nuclear exchange in a major war it would be vital to bring supplies from the West to ensure the survival of European civilian populations and the Allied armies in Europe, and later perhaps to build up those armies for offensive action. The vast tonnage of shipping required to carry these supplies would be exposed during a continuing war to an underwater threat immeasurably greater than ever experienced before. It has been suggested that the aeroplane could replace the cargo ship in an emergency—that essential supplies could be brought in by air. Investigation has shown that twenty Britannias would be required to lift the same amount of cargo across the Atlantic as a 10,000-ton cargo vessel in one year. Britannias would have to fly 3,000 hours each in that year, whereas the cargo ship would make four or five round trips. Apart from the cost (a new 10,000-ton cargo ship costs around £1½m while twenty Britannias would cost something in the order of £20m) they would require about 65,000-68,000 tons of fuel which would have to be brought to England in additional tankers.

Logistically, such a method of supply would be quite unsound. In two world wars in which the enemy has employed the submarine as his main weapon against our ships, he has been able to achieve success on a scale that gave cause for anxiety only within those areas where we were unable to put the bulk of our shipping into convoy with air as well as surface anti-submarine escort. The advent of the atomic bomb in no way detracts from the lessons learned in those wars, though it has complicated the application of the convoy system, because ships must be dispersed to minimize losses. Each convoy may have to cover a greater sea area requiring a greater anti-submarine escort effort. This requirement must be met from Allied naval resources in being at the start of hostilities.

The last-war submarines had three major limitations; low underwater speed and endurance, an inability to attack "blind" and a frequent need to surface or snort to charge batteries. These limitations have in the last fifteen years been largely overcome, the modern submarine having an underwater speed approaching that of today's surface escorts, and equipment for detecting surface ships at great ranges and attacking them "blind." One thing is certain, our A/S forces must be capable, numerically and technically, of doing their job from the outset of a global war. There will be no manning of reserve ships or expansion of industry to provide reinforcement once the nuclear bombing has started.

Anti-submarine forces consist of a complementary force of A/S ships, carrier-borne aircraft and maritime aircraft to provide defence in depth. This defence works on the principle of an inner defence of surface escorts strengthened by carrier aircraft operated farther from the Fleet with maritime aircraft providing distant support.

Today's carrier-borne A/S aircraft are the Gannet and the Westland Whirlwind, the latter being employed to reinforce the surface screen or on comparatively short-range sorties to specific targets beyond the screen. There are those, however, who believe that with improved performance and equipment the helicopter may advantageously replace fixed-wing aircraft altogether.



"Flight" photograph

Post-war Progress in Operational Equipment and Methods

By Cdr. H. C. N. GOODHART, R.N.

Development of the Aircraft Carrier

THE author of this article was responsible, in 1951, for putting forward the original idea of the mirror-sight landing aid for carrier aircraft, and is at present Commander (E) at R.N.A.S. Yeovilton. He is also well-known for his gliding activities and, with Frank Foster, won for Britain the World Two-seater Gliding Championship in France last year.

IMMEDIATELY after World War II the aircraft carrier entered a period of rapid development in order to accommodate the radically different naval aircraft then envisaged. In the United Kingdom the end of the first phase of this development was reached about a year ago, when the carrier force consisting of two fleet carriers (*Ark Royal* and *Eagle*) and three light fleet carriers (*Albion*, *Bulwark* and *Centaur*) were all in service equipped with angled deck and deck-landing mirror sights, together with catapults and arrester gear of adequate capacity for present-day aircraft. Coincident with the end of this phase has been the disappearance of the piston engine (except in helicopters and a small number of Skyraiders) and the picture is now one of a small but efficient force of carriers operating modern turbine aircraft.

It is interesting to compare our carrier force with the United States Navy, which is the only other large carrier force in the world. In size and numbers, of course, we are completely outclassed but in modernity we have no reason to hide our light. The U.S. Navy is only now in the process of introducing angled decks and the mirror sight, but on the other hand they have gone ahead faster in introducing the steam catapult* and higher-capacity arrester gear ("needs must" for their larger aircraft).

That our own force of carriers has reached its present state is a great tribute to the efforts of the scientists at R.A.E. Farnborough—and now at Bedford—and to the Navy's own Royal Corps of Naval Constructors who, between them, have developed all the equipment and carried through the ship reconstruction programmes. It also clearly demonstrates that the Navy at last fully accepts that the aircraft carrier has replaced the battleship in the rôle of capital ship; perhaps, also, it shows that the country is beginning to realize that the aircraft carrier alone can combine mobility, which will be all-important in nuclear war, with the enormous striking power of nuclear weapons, while at the same time providing floating bases to replace the fast-disappearing land-bases so necessary for the protection of our world-wide interests.

It might be said that the Suez operations were the world première of this new-born British jet-age carrier force—and from the operational point of view a brilliantly successful one. Few realize how great a proportion of the effort during these operations was provided by Naval aircraft or how dependent these results were on the smooth efficiency of the individual carriers.

It is the purpose of this article to show how the aircraft carrier has developed during the post-war period. The various developments may most conveniently be reviewed in sections concerned with the landing, launching, and deck phases of aircraft operation.

* *Like the angled deck, a British invention.—Ed.*

Landing. It is in the landing phase of carrier operation that the most startling changes have taken place. The war ended with a well developed landing technique in which the then-current tailwheel-type piston-engined aircraft landed under the control of a batsman, using a technique of a steepish descending approach at a speed very little above the stall, followed by a flare-out and cut which, when well executed, produced a most successful landing at the minimum possible speed and in the landing area. Unfortunately, increasing approach speeds called for a greatly increased degree of skill; and by the time the Sea Fury was in service, with its approach speed of around 90-92 knots, a stage was reached where the accident rate was high.

At about this time (1948) a decision was taken to switch to the U.S. system of batsmen's signals, which were the exact opposite in meaning of the British ones. (In the Royal Navy, arms-up meant "go up"; in the U.S.N., "Too much up".) This decision was taken in the interests of standardization but was, of course, no help in producing better deck-landing results; in fact, during the change-over period it led to some interesting differences of opinion between pilot and batsman as to exactly what was going on. These U.S. signals were not entirely satisfactory for controlling a British-type descending approach; soon afterwards, however, and in the interest of further standardization, the American approach technique was adopted. This consisted of a near-level approach to a point some 30ft above the deck and just short of the round-down, at which point a cut was given. On the engine being cut the nose dropped (these were piston-engined aircraft) and a normal flared landing could then be carried out in the landing area by easing the stick back. More speed was required than in the old British system and there was, therefore, more margin for small errors; but the greater speed had an adverse effect in that it increased the loading on both aircraft and arrester gear.

Introduction of the standard system produced some improvement in deck-landing results, but it must be remembered that we were still in the era of piston-engined tailwheel aeroplanes landing towards a collection of barriers, and the landing had to be exactly right first time. The greatest problem still remained —that of bouncing, and thus depriving the hook of a chance to gather an arrester wire. The tailwheel layout implied (though it need not have if two-position tailwheels had been adopted) that

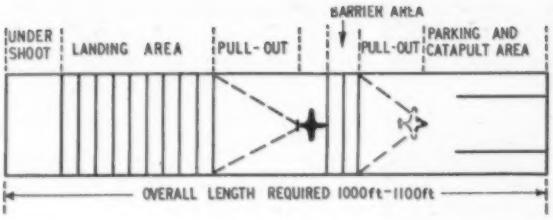


Fig. 1. (Left) Lay-out of axial deck.

Fig. 2. (Right) Layout of the angled deck.

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any aircraft going too fast would bounce when it hit the deck, and this was the source of many accidents.

It was clear to the authorities that regardless of any respite that may have been achieved by the adoption of the standard system there remained a rapidly increasing problem which would soon require a new solution. Already new high-speed types of jet naval aircraft were coming along, with inevitably increased landing speeds. The first problem to be overcome was the straightforward physical one of providing arrester gear capable of stopping these aircraft. This is, perhaps, an over-simplification, as the development of arrester gear takes just as long as, if not longer than, the development of aircraft; and so the aircraft was designed just as much for the arrester gear as the arrester gear for the aircraft. Nevertheless, it is correct to say that the rapidly increasing landing speeds of naval aircraft were forcing a high pace on the development of arrester gear.

In addition to the sheer physical development of the arrester gear (the required energy-absorption increases as the square of the entry speed, as well as proportionally to the all-up weight) a new problem began to be talked of. This was the impact of the hook on the wire, which above a certain engaging speed simply snatches a piece out of the wire instead of picking up the wire in the normal way—and it makes no difference how thick the wire is. The particular problem even led to talk of switching to some other material, such as nylon, in lieu of the high-tensile steel wire normally used. As yet this problem is still in the offing, but it remains as a threat if entry speeds are increased too far.

The improved arrester gears required an increased length of pull-out. Simple dynamics shows that for the same aircraft deceleration (i.e., same aircraft strength) the pull-out length required increases as the square of the speed. Of course, this increase can be held down by increasing the strength of the aircraft; but since this would involve a weight penalty it must be kept to a minimum and, inevitably, arrester gear pull-outs are increasing.

This increase of pull-out high-lighted a problem of growing difficulty. For high-performance aircraft it was impossible to design a conventional deck layout based on the existing carrier size. Equally, financial considerations precluded the building of a new carrier. Fig. 1 outlines the problem.

Existing fleet carriers have flight-deck lengths of about 850ft, and the problem of getting everything in was already acute in the piston-engine era. Some radical replanning was necessary, and it was in 1951 that Capt. D. R. F. Cambell, R.N., and Mr. L. Boddington put forward a brilliant solution in the angled-deck scheme. This solved the problem completely by doing away with the necessity for barriers altogether, and at the same time overlapped the landing, the parking, and catapulting areas. The new plan was basically as shown in Fig. 2.

One of the outstanding attributes of the angled deck arrangement is its flexibility. Flight-deck width becomes a substitute for length and the amount of parking space available is dependent on the accuracy with which pilots can be expected to land down the angled centre-line. Operation of one catapult, or even both, while landing is in progress is dependent on the degree of angle and the clearance necessary between landing area and deck operating area. At present all British carriers in service are fitted with what is known as a half-angled deck. This term simply means that the degree of angling has been kept down to that which could conveniently be achieved without major ship reconstruction. It is, however, strictly an interim phase to obtain advantages as quickly as possible, and does not give the ships the full capability which the principle of angling has made available. The semi-angling was, in fact, largely achieved with the aid of a paint-brush—i.e., simply by painting-in the angled deck. Though it provides the main advantage of angling in eliminating the barriers and allowing the "bolters" to bolt, it seriously reduces the operational capacity of the ship by reducing the size of the deck parking area. The importance of this is seen when it is realized that no lift can be operated while aircraft are landing, and thus landing must cease when the available parking space is full. It cannot be resumed until enough aircraft have been struck down to make way for the rest. From the operational point of view it is highly important that both launching and landing periods be as short as is humanly possible. Any increase in these periods seriously affects the "on the job" endurance of the aircraft, since extra fuel must be allowed for the additional waiting time involved, and at the same time the freedom of manœuvre of the carrier force will be increasingly curtailed.

The ideal angle of angling would be that which would clear both catapults from the landing area. This would then permit launching and landing to take place simultaneously and reduce to a minimum the period during which the ship had to be into wind. At the same time, parking space would be required for the landing aircraft and the best way of meeting this necessity would be a lift, clear of the landing area, which could be used while landing was in progress.

The deck-edge lift—which has been such an important adjunct to efficient deck operations in U.S. aircraft carriers and the lack of which was at one time considered one of the greatest shortcomings of British carriers—is not now in such great favour. It is extremely difficult to incorporate such a lift in a British carrier, owing to the fact that the flight deck is the strength deck; and there is a growing realization that a heavy penalty is paid in the reduced seaworthiness implicit in the large hole necessary in the ship's side at hangar-deck level and in the external structure required below this level. The original port-side position prepared for the deck-edge lift is rendered valueless by the introduction of the angled deck, and if such a lift was introduced now it would have to go into the starboard side. There is, however, the possibility of a normal lift (probably one offset to starboard) which would be clear of the landing area in a fully angled ship.

It has often been asked why the angled deck did not come earlier; but had it done so it might have been a failure, as it is completely dependent on pilots' ability to keep straight. With modern jet aircraft with tricycle undercarriage and an adequate forward view this is a very minor problem; but would it have been so in a piston-engined aeroplane with a tailwheel undercarriage, an atrocious forward view, and the difficulty of torque and its associated swing? A danger exists that forward view will deteriorate in future aircraft, and any tendency in this direction must be strongly combated.

Experiments soon showed that the angled deck was the beginning of a new era in deck landing. At last there was a chance to go round again—even after touch-down—if all did not go entirely according to plan; and at the same time practical deck layouts could be produced with the landing area where it should be and with the proper undershoot distance.

With the advent of the jet types and their high approach speeds another near new problem became apparent. It lay in what now seems to be called the "servo control loop" of the approach. There was simply too long a time-lag between the batsman appreciating an error in the aircraft approach path and the pilot correcting it. Clearly, this lag could be much reduced by eliminating the batsman and arranging for the pilot to appreciate any approach error direct. At the same time, it was also apparent that the landing flight-path implicit in the standard deck-landing approach was becoming progressively more unpractical as speeds increased. The system required (in a jet aeroplane) two distinct manœuvres, first a slight push over from the cut point and finally a flare-out for the landing. Judgment of these two manœuvres called for considerable skill, and while the penalty of flaring out too high was not serious in angled-deck ships, flaring out too late was inclined to push the undercarriage up through the wings.

Here again a radical breakaway from tradition was required. Consideration of a steady descending approach led to the conclusion that an angle of descent could be chosen which would fulfil the conditions for a safe approach path and at the same time obviate the necessity for a flare-out while remaining inside the absorption limits of the undercarriage. Fig 3(a) shows the after-half of a carrier in a calm sea and indicates the path followed by the undercarriage of the aircraft in a perfectly steady no-flare approach.

Fig. 3(b) shows the same carrier pitched bows-up in a heavy swell. The flight-path remains the same relative to the horizontal and the aircraft strikes the deck at the ship's pitch-angle plus the descent angle. This combination must not overstress the undercarriage.

Fig. 3(c) shows the ship pitched bows-down. The significant factor in this case is round-down clearance. In both cases reasonable allowances must be made for deviation from the perfect on the part of men and equipment; even so, it became apparent that the steady no-flare approach was practicable. [*Cont. on p. 381*

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It now became necessary to produce a device that would give the pilot instantaneous information about his deviation from the required descent-path. The defined path has to maintain its elevation relative to the horizontal and not to the ship's deck, and it was this consideration which resulted in the development of the deck-landing mirror sight. This consists of a gyro-controlled mirror, facing aft and alongside the landing area, in which the pilot sees reflected a battery of white lights placed aft of the mirror and pointing towards it. On each side of the mirror green lights pointing towards the pilot define a line across the mirror. If the image of the white lights is above the centre the pilot knows he is high, and vice versa.

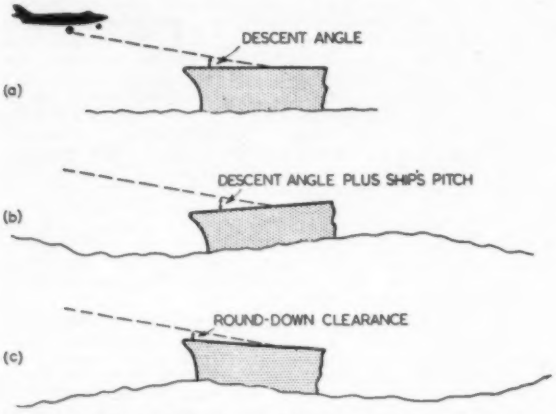

Fig. 3. Effect of ship's pitch in relation to final approach angle.

Since approaches are made from a circuit and since the mirror is not on the centre-line of the ship it is necessary for the mirror to cover a wide range in azimuth, and for this reason it is made curved in plan view. One part of this curve is then always reflecting light towards the pilot. This produces the effect that the white-light image moves across the mirror during the approach, but this movement is not significant.

The effect on a pilot of this new type of approach is considerable. He now has no set manœuvres to perform; it is simply necessary for him to fly the aircraft along the straight line defined by the mirror and deck centre-line and keep the speed at the required figure. In due course there will be a "crunch" as the aircraft strikes the deck and (provided the arrester hook picks up a wire) all that remains for the pilot to do is to close the throttle. In the event of the hook failing to engage a wire the throttle is opened as the aircraft runs along the deck and a re-take-off is made; the word "bolter" is applied to any aircraft which carries out this manœuvre. The problem with a "bolter" is then to fit him back into the landing sequence, which may well be very tight.

Originally, in this type of approach a pilot was receiving all his information through his eyes. The most important items of information are elevation, line and airspeed. Elevation and line came from looking at the carrier (mirror and centre-line) while airspeed was obtained by looking down at the A.S.I. It was thought that this concentration on only one channel (the eyes) for feeding information to the pilot's brain was inefficient and that better results could be obtained if an additional channel was used. The simplest spare channel seemed to be the ear (taste, smell and intuition seem a shade less practical) and the most appropriate piece of information for it to convey was airspeed. Thus there would be no need for either moving the eyes or refocusing them during the approach. This was the thinking which led to the development of the audio A.S.I., which is a device that puts a signal in the pilot's earphones to let him know whether he is at, above, or below his correct deck-landing speed. Considerable work was carried out at the R.A.F. Institute of Aviation Medicine by Surgeon-Cdr. W. H. B. Ellis, A.F.C., R.N. (one of the Navy's flying doctors) to develop a reliable device that would give an audio signal which all pilots, regardless of their musical ability, could interpret clearly and unmistakably. Such a device is now fitted in modern deck-landing aircraft and, though not universally liked by all pilots, is steadily gaining ground.

This brings the story up to the present day. The comparative table (at the foot of col. 2) for fighter type aircraft outlines progress since 1948.

From this it will be seen that a complete metamorphosis has been achieved, and it is nice to realize that this has been done in the Royal Navy well ahead of the U.S.N.

All the foregoing concerns the technique of deck-landing, and we now come to the ship aspect. Mention has already been made of the vast amount of energy to be absorbed in the arresting of a heavy high-speed aircraft, but that is one of the lesser problems of the design and development of arrester gear. For efficient arrest the aircraft must have a constant force applied to it throughout the landing run. If this force is too large the aircraft will break; if it is too small the aircraft will not stop in the required distance. The designers find it very difficult to design an arrester gear to cope with the very high engaging speeds now envisaged, and much ingenuity has had to be used. Successful arrester gears continue to be available in time to meet new aircraft, and the latest designs produce performances which, ten years ago, would have been considered impracticable. (In parenthesis, it may be explained that the energy absorption is achieved by squeezing fluid through controlled orifices at high pressure, and consequently the energy is converted into heat. The amounts of heat are large. Consider a 30,000-lb aeroplane landing at an engagement speed of 100 kt. The energy to be absorbed is $Wv^2/2g$, i.e., 1.3×10^7 ft lb, or 17,000 B.Th.U. In a well-worked-up squadron landings take place at less than 30 sec intervals, so that there is a considerable amount of heat to be dissipated.)

Another major problem of aircraft-carrier design is deck strength. When the aircraft lands the entire vertical velocity must be absorbed in the travel of the oleo legs plus the tyre deflection. Very high reaction loads are therefore required from the deck, and since the landing point is inevitably over the hangar it is clear that very heavy beams are required to keep the aircraft from going straight through into the hangar. It is a very major piece of reconstruction work to increase the deck strength of a British carrier, since the flight deck is a major part of the ship's structure; in a U.S. carrier, on the other hand, the flight deck is part of the superstructure, and so the problem is less acute.

In the design of barriers considerable development has been required. For piston-engined aircraft in axial-deck ships multiple-steel-wire barriers were used which stopped an aircraft that had not picked up an arrester wire. Considerable damage was frequently done to the aircraft; in fact, the primary purpose of the barrier was to keep the aircraft out of the deck park and to save the pilot, more or less regardless of damage to the machine.

With the switch to the angled deck the function of the barrier changed completely, and it became a device for saving aircraft. Without it, any aircraft suffering a damaged hook, or one which could not be lowered, would have to be ditched; or the crew would have to bale out. From the crew point of view this is probably an equally safe way of getting back to the ship, since helicopter rescue techniques are now so good; but the aircraft is inevitably lost.

This change of philosophy completely alters barrier design. In axial-deck layouts the barrier was inevitably a fierce device, since space for its pull-out was very limited; but in angled-deck ships the barrier carries out the same function as an arrester wire and has the same amount of pull-out space available. It is, in fact, rigged on to one of the standard arrester-gear units when required. In order to minimize damage to the aircraft, the steel wires of the old-type barrier are replaced by a cunning system of vertical nylon straps between a top and bottom strap, the vertical elements clasping the aircraft wing round the leading edge. It is essential that the top horizontal strap passes above the cockpit enclosure, otherwise the canopy may be cut into—or even off. It is also essential that the wings be strong enough to take the loads. The great day for this device came during the Suez operations, when an aircraft had to make a hookless landing; it was brought to rest neatly and smoothly and the crew stepped out completely unruffled. The pay-off to the story is the fact that the aircraft was virtually undamaged and was ready again for operations 24 hours later.

One other item which is important from the point of view of close landing intervals is the ability of the aircraft to clear the gear quickly after being arrested. Fortunately this can be achieved

	1948	1956
Type of aircraft	piston-engined	jet
Undercarriage layout	tailwheel	nosewheel
Approach airspeed	90-92 kt	115-120 kt
Type of approach	steepish descent, flare-out	medium descent, no flare-out
Source of elevation information	batsman	mirror
Source of line information ...	batsman	centre-line
Source of airspeed information	A.S.I. and batsman	audio A.S.I.
Forward view	atrocious	reasonable
Deck layout	axial	angled
Barriers	yes	no
No. of arrester wires	ten or more	six or less
Type of landing	engines cut	no cut

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relatively simply by providing a hydraulically retractable hook (this sounds elementary, but for a long time hook retraction was carried out manually by the deck party). Even the retractable hook is not a complete solution, however, and pilots must be trained to avoid keeping the revs up after landing; otherwise the aircraft will not run back the small amount necessary to slacken the arrester wire and allow it to drop off the hook. For the same reason it is necessary for the pilot to avoid putting the brakes on too early. Consideration has been given to a positive device for ejecting the wire from the hook; but since the problem can be overcome by good pilot technique it is unlikely that any solution which adds weight and complication to the aircraft will be accepted. The importance of such an apparently small detail can only be fully appreciated when it is realized that an extra five seconds in clearing the landing area will mean that the next aircraft will have to be waved off, and there will then be an interval of 23-30 sec before the next appears.

Launching. The problem of launching an aircraft from a carrier has many interesting facets and, like landing arrangements, it has been largely revolutionized in the last ten years. At the end of World War II all aircraft were capable of a free take-off from the deck provided that about 30 knots of relative wind could be provided. Catapults (they were called accelerators at the time) were provided, but they were only used either when the wind down the deck was lower than usual or when a very large range of aircraft were to be launched and the deck space available for the front ones was insufficient. Under such conditions free take-off would be resumed as soon as the deck had been cleared sufficiently.

The catapults of this era were of the type in which launching energy is stored in the form of compressed air which acts through an intermediary fluid on the main ram. This ram is connected to the aircraft by a system of pulleys and wires which have a mechanical disadvantage ratio of the order of 8 or 10, i.e., the ram moves only one-eighth the distance of the aircraft during the launch. After launching, the fluid is pumped back by a steam-driven pump, thus recompressing the air for the next launch. This type of catapult was quite satisfactory and presented no insuperable design problems, but the aircraft which it had to launch weighed only up to 10,000 lb and the end speed required was not above 65 kt.

The next step, however, was not so easy; the jet aircraft with its higher launching speeds was just around the corner, and aircraft weights were being mentioned which sent cold shudders down catapult designers' backs. Research had shown that the design problems of the hydro-pneumatic type of catapult became much more serious as the energy requirement increased. Both U.S. and British experience has since demonstrated that aircraft of present-day naval fighter size and performance represent about the ultimate that can be launched successfully by the hydro-pneumatic system.

Fortunately, at this time Cdr. C. C. Mitchell, O.B.E., R.N.V.R., came up with plans for the direct operation of catapults by steam. Now, ten years later, one British carrier (*Ark Royal*) is equipped with steam catapults, and the elapsed period indicates the enormous amount of development which has gone into this piece of equipment.

The technical details of the steam catapult are completely fascinating, but only its effect on aircraft carrier development must concern us here. Launching is a complicated procedure and involves a surprising number of steps. First, the aircraft must be taxied into exactly the right position and, furthermore, its nosewheel must be pointing along the catapult track; then the launching bridle which joins the machine to the catapult shuttle must be hooked on, and at the same time the hold-back unit must be attached which restrains the aircraft prior to the actual catapult firing; next the engine is run up to full power; and, finally, when the pilot has indicated he is ready, the catapult is fired. All this occurs on deck. Down below, meanwhile, various steps are being taken to bring the catapult to readiness at the right moment and to ensure that it is adjusted to give the correct strength of shot for the particular weight of aircraft and end speed required. Thirty seconds later the cycle should be recompleted and the next aircraft launched.

To achieve this rapid cycling, attempts have been made to introduce automation. The first item is roller-positioning gear. This consists of powered rollers in the deck just short of some mechanically operated chocks which are faced with rollers. The aircraft taxies up to the chocks and the roller-positioning gear then moves it bodily sideways until it is central; sometimes, however, this leaves the noseewheel skewed, and it has to be straightened by hand.

Despite attempts to arrange for the launching bridle and hold-back unit to engage automatically, this part of the routine is still manual.

Time-saving in loading-on the aircraft is not, however, of primary importance, since the catapult must in any case be prepared for the next firing. This is at present the limiting factor, particularly in the steam catapult, where recovery of pistons calls for considerable power and cannot be started until all the steam has been exhausted from the cylinders.

Another problem in catapult launching is the recovery of the bridle, which varies from aircraft to aircraft but is in general a steel wire strop about five to six feet long and of about 1in diameter. At the present time, and despite numerous attempts at designing satisfactory recovery gear, it is lost on every launch. It would seem easy to arrange to retain it at the end of the launch, and this is indeed so; but to hold on to it and also be absolutely certain that it does not hit the aircraft is quite a different matter.

In catapult design there are some interesting general considerations. At first sight it would seem necessary only that the airspeed at the end of the launch should be greater than the stalling speed. However, other points arise. First, the aircraft must accelerate from this speed, i.e., it must not be too far on the wrong side of the drag curve; secondly, its attitude must be such that the required lift can be developed. In tricycle-undercarriage aircraft this can be a big problem; it is one that has led to the consideration of various arrangements to give the required attitude during the catapult run. A simple solution would be to have a free deck run beyond the catapult end; but this is completely impractical, as it is essential for deck-space economy that the catapults be as far forward as is possible. The necessity for this aircraft rotation after launching makes extra catapult end speed necessary, since the aircraft starts to sink while building up the lift to equal weight, and extra lift is then required to overcome this sink. This extra lift cannot be produced unless there is some additional airspeed.

In this context it is interesting to consider the possibilities of the elevated catapult. For aircraft with high thrust/weight ratios quite startling reductions in catapult power required can be achieved by quite small angles of elevation. The theory behind this is that the catapult only launches the aircraft to a speed below the stalling speed, but the aircraft has an upward component of speed which can be allowed to drop to zero before it is necessary to start flying. During this period the engine thrust is building up the speed and it is only necessary that this be equal to the stalling speed when the vertical velocity has fallen to zero. Our ships still have flat decks; but elevated catapults are now feasible, thanks to the disappearance of free take-off and the introduction of angled decks.

A major problem associated with launching of aircraft is noise. It is essential that engines be run up to full thrust before launching, and this produces noise intensities both on the deck and inside the ship which are already approaching the limits of human tolerance; communications are interrupted and orders cannot be given. The problem is serious with present-day aircraft and will become progressively more so as higher-powered types are introduced. The possibility of rocket motors in the future may compel some radical reorganization.

Coupled with the noise there is also the matter of engine efflux, which heats the deck plating behind the catapult launching point to an excessive degree. Apart from the difficulty this causes in the compartments immediately below, there is also the effect on the tyres of the next aircraft when taxying into position. To overcome this it has been necessary to install water-cooled panels in the deck in the area where the jet blast strikes.

Yet another problem arises from the efflux, and that is the danger to men and equipment further down the deck. Already there may be a 30-35 kt gale blowing down the deck, even though the natural wind be only a light zephyr. Add to this the blast of an aircraft at full bore, and men and equipment will be tossed about like straws; so, in addition to a cooled deck, it is also necessary to provide deflectors to break up or deflect the jet stream.

From the operational aspect, and for the same reasons as in landing, launching must be conducted in the shortest possible time. It is usual to use both catapults at once, firing them alternately, so that an aircraft will leave the ship about every 20 sec and each catapult will be running on a 40-sec cycle.

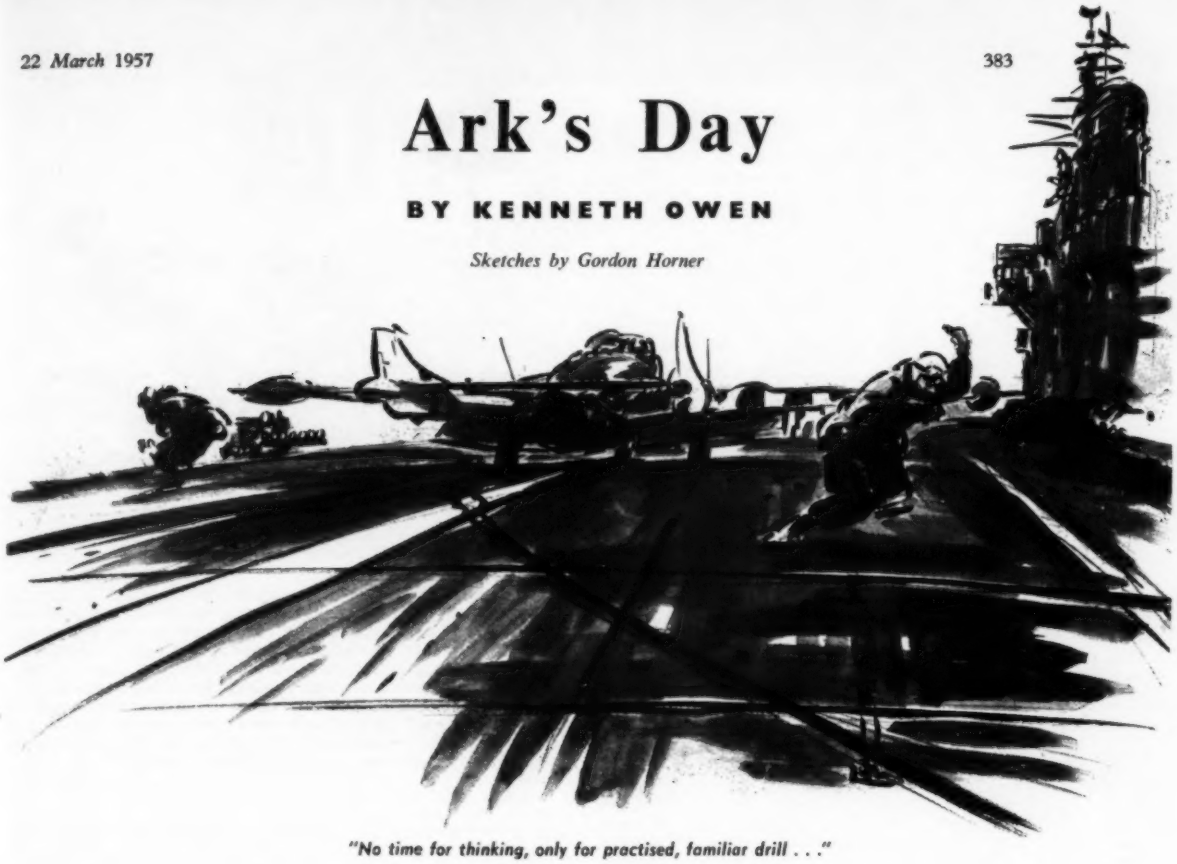
A perfect catapult would, in a similar way to an arrester gear, apply an exactly correct and constant force to the aircraft, this force being that necessary to reach the required end speed at the end of the catapult stroke; again as in arrester gear, this perfection is not achieved; and since the peak force must not exceed the aircraft designed strength the theoretical end speed for a given aircraft strength and catapult length cannot quite be achieved. This dependence on aircraft strength and catapult length is a matter of elementary dynamics ($F = ma$ *and* $s = v^2/2a$) and sets the designer of an aircraft an interesting problem. The catapult length is a fixture—it would mean an enormous ship-reconstruction programme to alter it and, anyway, it would intrude seriously into the deck area and force the lift further

(*Continued on page 391*)

Ark's Day

BY KENNETH OWEN

Sketches by Gordon Horner



"No time for thinking, only for practised, familiar drill . . ."

THE flight deck was grey and still when, shortly before dawn, the sharp bugle-call sounding "flying stations" was heard throughout the ship. She bore a proud and well-remembered name and she had sailed from Gibraltar at midnight. To starboard flashed the light of Punta de Pescadores, many miles away on the coast of Spanish Morocco; the first day of a week's intensive flying was just beginning.

Most of the aircraft borne by the great ship were at that time in the two hangars beneath the flight deck. Wyverns, Sea Venoms and Skyraiders in the upper hangar, Gannets and Sea Hawks below, with the two "Ship's Flight" helicopters in a bay of their own, level with the upper hangar but separated from it by the cavernous forward lift-bay. In the hangars the vast space was foreshortened by the close-packed bodies of the machines and the broken angles of their folded wings. The large, bright deck-head lights were reflected in the upper skin surfaces as the squadron maintenance men busily completed their pre-flight chores.

For the squadron personnel in the hangars, as for the whole ship, "flying stations" had indicated that flying would begin in one hour. In this time the various aircraft needed for the day's first sorties must be taken up by means of the three lifts to the flight deck, spotted (parked in position for take-off) and armed. Obviously the hangar people had had an early day.

In this they were not alone. Among the many others whose jobs demanded an early start to the day were those—such as the meteorologists and the operations staff—responsible for the briefing of the pilots. Weather information, clearly, must be the latest; while much of the "Ops" briefing could be prepared the previous night, the current details of the ship's position and movement, of diversion airfields and of any changes in the planned exercises must be added at the last moment.

Aircrew briefings that day were to take place 45 minutes before the time of each launch, with the first launch—"Detail A" on the flying programme—planned for 0815. This detail was to comprise six Hawks, four Wyverns and one Skyraider. The Hawks were to carry out high-speed interceptions, the Wyverns were to make dive-bombing and rocket attacks on smoke markers, and the lone Skyraider's task was to extend the general area of air defence.

As the pilots were being briefed in No. 1 briefing and ready room—on the ground floor (so to speak) of the island—the folded wings of aircraft being towed to their allotted "spots" could be glimpsed as they passed across the small circular ports on the deckside of the room. Outside, on the deck itself, there was now a steady activity.

Up on the deck-edge lift, on the port side just opposite the island, came the Wyverns, then to be spotted on that same side of the deck. From the forward centre-line lift emerged the Hawks, to be towed and manhandled into position on the starboard side and forward. At the after end of the deck was the blue Skyraider, which spurned the use of the catapults in the bows.

A final, essential aircraft, though not listed in the day's flying programme, was also brought up on the forward lift from the bay where it nested with another of the same type. It was one of the two Whirlwind helicopters whose unobtrusive yet vital task was soon to be apparent. The lift was stopped while the Whirlwind's rotor blades (at deck level) were unfolded and locked, then the ascent was completed and the machine parked nearby.

Around and between these various aircraft now bustled a stream of energetic humanity, punctuated by the sharp movements of the towing vehicles. With all machines finally spotted, there remained only the fitting of bombs and rockets to be completed on the Wyverns (with wings still folded), and last-minute snags to be dealt with—quickly.

"Flight deck, ready rooms," the loudspeakers' call went out for the first time that day, "aircrew man aircraft." The voice came from a narrow, enclosed platform jutting out over the deck from the side of the island. This was Flyco, the flying control position, and the voice was that of Lieutenant Commander (Flying). His key position adjoined the navigating bridge, and was connected by voice tubes, telephone and intercom to all the various specialist units concerned with the ship's air operations.

"Little F," as Lt-Cdr. (Flying) is known, also had R/T contact with aircraft in the carrier's circuit, for he was responsible for all aircraft operations in the circuit as well as on the flight deck. While launches were taking place and when aircraft were landing-on, Flyco was the place where the team effort that was the flight-deck organization was co-ordinated. Logically, Flyco was only a few paces from the compass platform where the Captain sat in command of the ship.

The call to man aircraft came 15 minutes before launching time. Emerging from the island, the Hawk and Wyvern pilots walked across to their machines, completed pre-flight inspections, and climbed into the cockpits. As they were being assisted in strapping and connecting themselves to their aircraft, parachutes, dinghies, oxygen supplies and radio sockets, the flight-deck loudspeakers called "Start up helicopter."

The tempo of the deck movements had gradually been increasing, and there was now less than ten minutes to go. As the sun rose above the horizon, flaking the clear sky with a subtle orange,

Ark's Day . . .

the flight-deck breeze was rippling the "goonskin" weathersuits of the yellow-vested directors, under whose signals the aircraft would be taxied to the catapults.

"Stand by to start up Skyraider and Wyverns . . ."

"Stand clear of propellers and jetpipes . . ."

"Start up Skyraider and Wyverns."

The helicopter had taken off now, and was tilting round to its port-beam position, where it would remain, formating on the ship, during the launching period. "Plane-guard" was the simple title of the chopper's duty. If an aircraft crashed into the sea, the Whirlwind would be over the spot in a matter of seconds, trained aircrewman and winch at the ready.

"Stand by to start up Sea Hawks . . ." "Stand clear of jetpipes . . ." Little F pushed down his window and extended his arm to finger-signal the seconds as he went on to call "Five, four, three, two, one—start." His signals were repeated by the Pilot's Mate at the nose of each Hawk. After a brief pause, the characteristic plumes of smoke hissed up from each machine and the Nenes whined into life.

All engines were now running. The Wyverns' contra-props and the Skyraider's propeller-disc were glinting in the sun, and the Hawks were warming the island with their Avcat-smelling breath. Beneath each aircraft two figures lay full length, clasping the mainwheel chocks.

Maintenance personnel, armourers, the men with portable fire-fighting equipment and those with starter trolleys for the Wyverns and Skyraider had now disappeared from the deck, leaving it clear, once chocks were removed, for the aircraft directors, and for the huddled group at the catapult position. First to move up for launching were the Hawks, passed from one director to the next until the first two aircraft were positioned on the catapults. The ship completed her wide curve into wind. Flag "Foxtrot," previously at half-mast, was fully hoisted, indicating that flying was in progress; the Flight Deck Officer raised his green flag, "wound up" the Hawk on the port catapult and whipped the flag down; and the aircraft shot forward along the groove. It was exactly 0815.

Little time was wasted as the remaining Hawks taxied forward, were positioned on the catapults, alternately port and starboard, and launched. After an adjustment of the aircraft attachment points on the catapult, the Wyverns followed. Finally, from the after end of the deck, the pilot of the Skyraider opened up his Cyclone to begin a free take-off along the "angled" centre-line. Satisfied that all was well, the helicopter pilot brought his machine in to a smart landing near the forward lift, just six minutes after the first launch.

The day's flying had begun. The programme itself was an intensive one, though typical of carrier flying. It was based on a launch-to-launch time of one hour five minutes. This meant that, at 0920, the second detail of 10-18 aircraft would be launched, followed immediately by the landing-on (or "recovery") of the first detail. At 1025 the third detail would be launched and the second would land-on, and so on. This cycle of one hour and five minutes was to be repeated throughout the day and, in slightly modified form, during the night flying which was to continue until the last land-on at 2320. A long day indeed, but one which followed a familiar, routine pattern for *Ark Royal*'s aviators.

"Stand by to start up Sea Hawks . . . five, four, three, two, one . . ."

"The flight-deck air was a rushing force: men had to lean into it . . ."

Only teamwork made possible a programme like this. A complicated, magnificent teamwork which involved specialists in scores of different trades, from those watching the radar scopes of the Aircraft Direction Room to those watching sausages in the infra-red grill of the aircrew refreshment bar. Perhaps, by looking around, we may gain some idea of what is involved.

* * *

One basic problem is that of aircraft movements while aboard the ship. When one's airfield measures only 800ft × 110ft, and passage of aircraft between hangars and runway is possible only at three points, and there only in a vertical direction, these movements need to be planned with exactness and certainty. This is the responsibility of the Aircraft Control Room Officer, who reigns with an urbane sanity amid the confused bedlam that is the A.C.R.

He is concerned basically with knowing where each aircraft is on board and whether it is serviceable. The serviceability state is displayed on a wall board, while aircraft positions are exhibited by means of silhouette models on three long, glass-topped trays representing deck and hangars. From this information he decides which aircraft are to be moved where, and how; and attempts to reconcile conflicting (or just awkward) requirements. It is not very helpful, for example, if an aircraft needed on deck is separated from the nearest lift by two unserviceable machines.

As well as three-dimensional space, the time factor is a major consideration. The A.C.R.O. must know—and must know immediately, from his own experience—how long to the nearest second it takes for a Hawk to be launched, a Venom to land-on and be ranged. The planned movements, and several alternative plans to cover likely snags, must be fitted into the precise time-scale that is the basis of carrier flying. And they must be fitted in mentally, immediately. One would hesitate to challenge the A.C.R.O. at chess.

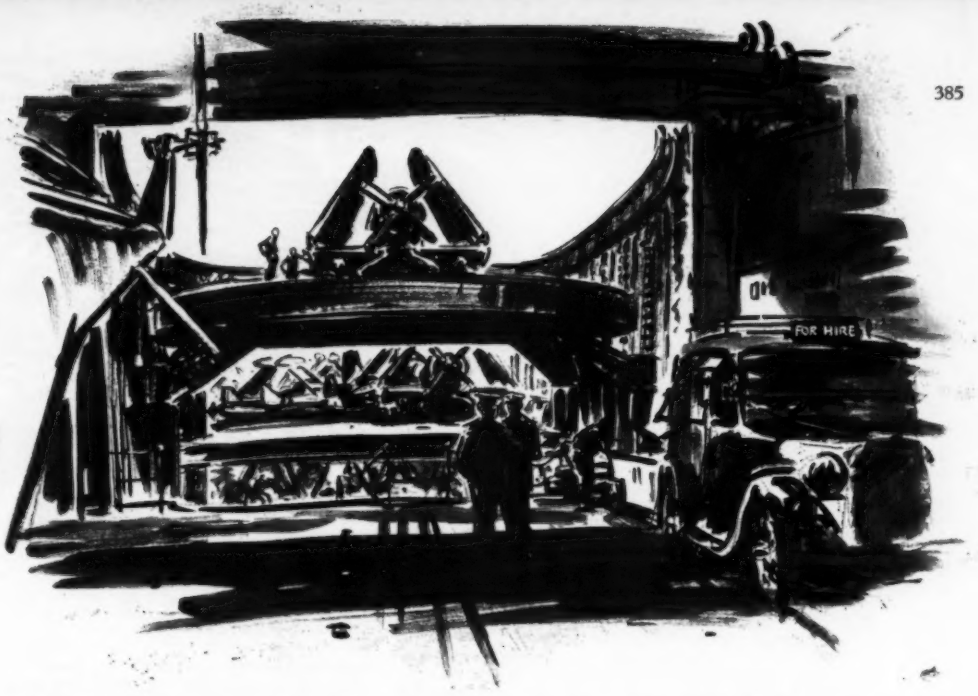
Thus it was his job when, for instance, "6HK, 4VE, 4GA," was specified on the flying programme as the 0920 launch, to make sure that six Sea Hawks, four Sea Venoms and four Gannets were ready in position on the deck at the appropriate time. The aircraft would then come under the overall control of Lt-Cdr. (Flying) until, after launching, they left the ship's local R/T frequency and began their respective exercises. During the time they were away from the ship, control of the aircraft, or at least a check of their position, would be in the hands of the Aircraft Direction Room or the Operations Room. Similarly, on returning to the ship, A.D.R. or Ops would pass control over to Little F, who in turn transfers responsibility to A.C.R.O. when all aircraft have been recovered.

The aircraft themselves, the eyes and punch of the ship (and, indeed, its very *raison d'être*), belonged to six squadrons, each a self-contained unit in many ways yet attaining full effectiveness only in conjunction with the other squadrons and with the ship.

The anti-submarine rôle was filled by the Gannets of 815 Squadron, and it was in one of their machines, flown by the C.O., that I received my first impressions of flying from and landing on the deck. It was to be a gentle introduction, for the Gannets were employing free take-offs.

The most alarming sensation was that of insecurity when

Ark's Day . . .



Lift-well view from the helicopter bay, with Skyraider en route. The taxi was definitely not standard carrier equipment.

spotted initially in a position at the port after corner of the deck. The brakes held, however, and from the observer's seat I looked across at the two other Gannets with whom we were to carry out bombing practice. Emphasizing the restricted space on deck, their green Guinness harps, the squadron's auxiliary-fin badge, seemed all too close.

"Start up Gannets" floated to us across the deck, and then we waited as the Hawks and Wyverns were launched. An incoming flight of Hawks called up Flyco, and over the R/T we heard, "37 Leader, this is Flyco. We have one Hawk, four Wyverns and three Gannets to go. Over . . ."

The launches continued until, after the last Wyvern launch, the catapult crews ran to each side and the port catapult-control howdah was lowered, clearing the deck for the Gannets' take-off. Our take-off was straightforward, pleasant and uneventful—only later did I think of the 650ft take-off run, which then seemed rather short, and the indicated speed at which we were airborne, which seemed rather low. After clearing the deck, we stayed below 300ft and flew straight out until clear of the incoming flights.

While the Hawks were making practice R.P. attacks on the splash target being towed behind the ship, we filled in time with some merchant-ship scouting (estimating length, speed and tonnage and noting the ships' names), and with a practice bad-weather let-down controlled from *Ark's* Aircraft Direction Room. Returning to a wide circuit of the ship for the anti-submarine bombing, we contacted "Royston Spotter"—the gunnery officer who was checking the accuracy of our attacks from the ship—and were cleared to begin our series of dives. The accuracy of the Gannets' bombing was called to each individual aircraft after each pass.

Pre-flight briefing of aircrew by Ops. 2, Lt. Cdr. Harvey.

Orbiting the carrier in echelon, we watched Hawks, Venoms and Wyverns landing first, before it was time for our formation to break to port and for each machine to lower hook, wheels and flap and complete the downwind leg. We curved round on to finals at about 400ft and flew steadily down the mirror-marked groove. The actual touchdown was smooth, and the wire's restraining pressure was firm but gentle. Certainly I lunged forward against the straps, but there was no discomfort. My mind needed a few seconds to adjust, however; the experience of being airborne one minute and at rest on a ship—even a carrier—the next, was new and novel. But we had arrived, and this in itself was quite a thought.

There was, however, no time for thinking, only for practised, familiar drill as we came under the control of the yellow-jacketed directors. Almost before we had been pulled to a stop by No. 2 arrester wire, two hook-men had run out to the Gannet's tail (one from the port catwalk, one from the group of vehicles near the starboard mirror) to release the hook, and a director was signalling to us from the starboard side of the deck. Let her roll; brakes on; hook free; forward; select wing-fold; and on with a decisive, pointing arm to the next director, who happened to be the Flight Deck Captain.

This chief petty officer, responsible to the Flight Deck Officer for the efficiency of all the deck ratings, came from an old Naval family. Without a word, he managed to convey, in a single or emphatically repeated gesture of his arms, a complicated executive command, an expressive comment on the speed with which it was carried out, and (if necessary) his overall opinion of the man concerned.

He needed this ability, for no word, either spoken or yelled, stood the slightest chance on the flight-deck air. Keen from the wind and the ship's own speed, warm and Avcat-tinted in the gusts from Ghost, Nene or Python, this air was a rushing force. Men had to lean into it—and even then it tore at their clothes as if they, and not flag Foxtrot, were at the top of the mast.

Now the Flight Deck Captain urged us over towards the starboard side of the deck, and passed us on to the final director in the deck park just forward of the island. The Gannet behind us was just touching down. As for us, we were jostling into position, behind what seemed already a tightly packed bunch of Hawks and Venoms ranged in "Fly One"—the forward, starboard slice of the deck. Hawks three abreast, Venoms and Gannets two abreast, all were clear of the angled runway—and clear of the safety lane on the starboard side of it.

My trip had ended as it began for, once again, as the director eased us into position inch by inch, I had that uncomfortable deck-edge feeling. Yet I had faith in the director, and also in Shorty, the control room officer, who at that moment would be looking forward out of his midget bay-window, passing a silhouette model of a Gannet to his assistant at the dummy-deck tray, and saying briefly, "295. Outboard." We were Gannet 295, and we had fitted where intended into his plan. Five Hawks had been

turned and ranged in the shadow of the island; we walked past them and into the island itself.

* * *

As the whole object of carrier operations is to put aircraft in the air capable of detecting or attacking an enemy or of defending the fleet, the control of these operations from the ship is one of the most important aspects of the carrier's task. Control is exercised from the Operations Room and the Aircraft Direction Room, which are in effect the upper and lower levels of a two-floor operations headquarters, located in the island.

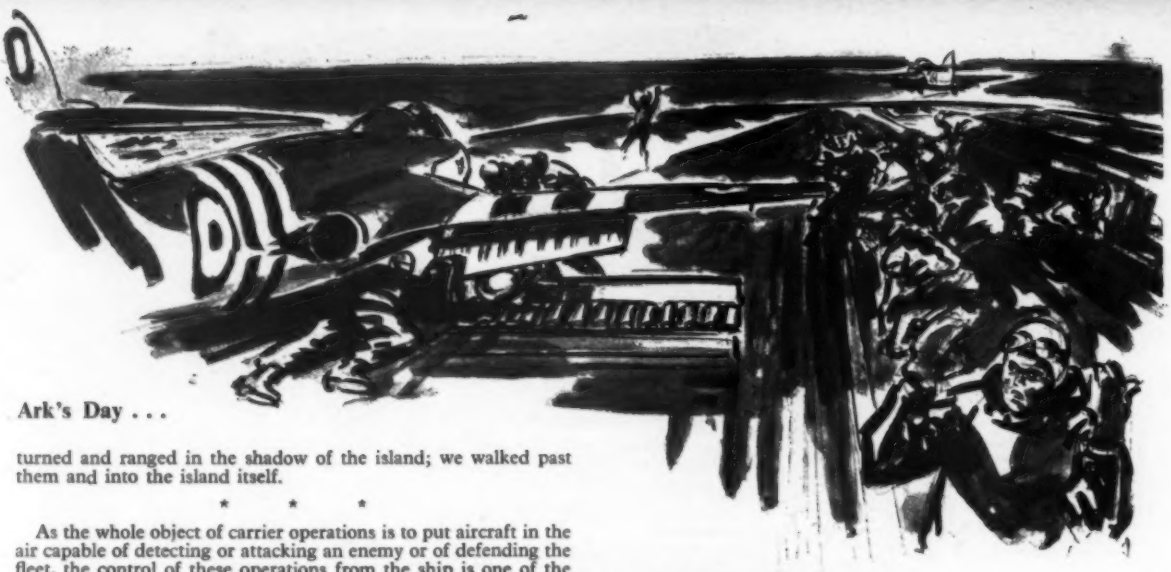
The A.D.R. is concerned mainly with the direction of fighter aircraft in defence of the Fleet. On two large "spider's web" Perspex panels are displayed the main air display plot and the local plot, between which is the "tote" board listing call-signs and supplementary information concerning particular aircraft shown on the plots. Above these (at Ops-room level) are the Perspex aircraft-state boards for the carrier's own aircraft; all this information can be viewed from both the A.D.R. and the Ops-room.

The radar displays viewed by the direction officer and his assistants include long-range and short-range equipment. During this week, much effort was to go into practising high-speed interceptions, A.D.R. directed, by Venoms and Hawks. In bad weather, the ship's aircraft would be vectored during their initial let-down from the A.D.R., and handed over to another direction officer in the carrier-controlled approach (C.C.A.) room for final approach.

In the darkened Aircraft Direction Room, shadowy earphoned figures were moving behind the illuminated plot boards. They received their information from the radar operators, and transferred it (writing backwards and in mirror-image, for it was viewed through the Perspex) to the reverse side of the plots. In front of the displays was a plotter who selected and transferred the information to the front of the boards where the directors could see it.

Above the A.D.R., and overlooking through tall windows its display plots, was the Operations Room, where Lt-Cdr. (Ops.) and his staff must have the overall picture of surface and air movements in the region of the carrier. Patrols and searches by the ship's aircraft are normally handled here, and are related to the movements of surface vessels and in particular to those of the parent ship.

In a carrier such as *Ark Royal*, the Operations Room was designed to be the centre from which the Admiral commanding



"An immediate concentration of effort . . .": the steady flow of aircraft being launched.

a carrier task force, were his flag carried in *Ark*, would make his major decisions. The Admiral's bridge and staff office, accordingly, adjoin the Ops room, in which are provided special desk positions for staff officers (overlooking the A.D.R.) and for communicators.

Routine operations work is carried out at three plotting tables, which incorporate automatic indication of the ship's position by light projection from below on to the ground-glass table-tops. One table carries the local plot, one the surface and air picture,

Getting down to it: literally flight-deck level for the chock-men.

and the third the geographical and operational plot. This week of intensive armament practice would not involve as much activity as during full-scale exercises—which would enable Ops to devote more time to his many other responsibilities in generally co-ordinating the ship's operations—but a number of night navigation exercises for Gannets were included.

Even when the plotting tables were quiet, there was much to occupy the Ops-room staff, from the Operations Officer checking incoming signals and amending briefing data to the shadowy figures behind the "aircraft state" Perspex columns.

* * *

The morning passed quickly. With the entire Air Department geared to the steady 65-minute cycle, and with many jobs to be done every minute, this was not surprising. Lunchtime in the wardroom found few of the Air Department section-heads present (a special bridge mess beneath the island catered for those on duty there), but the varied specializations of those who were there gave a reminder of the vastness and complication of the ship's organization necessary to provide and run this mighty, floating airfield. For the teamwork required is not only that between different sections involved in the flying side, it is also the more difficult one between fish-head and aviator.

Many Fleet Air Arm pilots and observers, however, have served in (and commanded) ships other than carriers, and the two-way exchange of experience and outlook has been one of the factors which have produced today's fully integrated Service. Certainly there was no better or more unified team than *Ark's*—notwithstanding the opinion voiced by one of the ship's water-distillation engineers that "these aviators think they've got Lake Coniston on the end of their showers," or the quiet comments by various aviators concerning the ship's turbine defects which were to cause a premature return to England.

My request for first-hand experience of the steam catapult had

"Dear Mum, Here in the upper hangar things are pretty busy, but . . ."

been granted by courtesy of 893 Squadron, who had agreed to accept a passenger instead of an observer in one of their Venom 21s in detail F, to be launched at 1340. High-speed interceptions were the task, to be carried out in pairs (the fact that Royston 39-3 carried "negative observer"—reported by R/T during the flight—was therefore not as calamitous as it might have been).

A 1340 launch meant a 1255 briefing, and this in turn had implied lunch in "Noah's Cabin," otherwise known as the aircrew refreshment bar, for the aircrew concerned. From Noah's Cabin it was only a short walk to No. 1 briefing and ready room, one of three in the ship.

Around the walls of the briefing room, comfortably furnished with red, high-backed airline-type seats, were mounted eight briefing boards, each referring to a particular aspect of the flight. Facing the aircrew were two basic-information boards, one the crew and duty list (giving details of aircraft, call-signs, etc.) and the other listing tactical orders. On the side walls were similar boards respectively dealing with navigation, met., radio, recognition, merchant-ship movements and general information. With this information on display, the verbal briefing could be confined largely to the emphasis of exceptional or topical points. Small lockers at the rear of the room accommodated bonedomes and inner helmets.

A young, bespectacled instructor-lieutenant began the briefing with the met. forecast, concentrating on local conditions and short-range prospects. Next was "Ops. 2," who briefly covered the various tasks, diversion airfields and local conditions ("A special note on Gib.—in these conditions it is extremely gusty at North Front"). Finally the flight leader covered points of operating detail, on the deck and in the air, and dealt with snags which had arisen during previous flights that day.

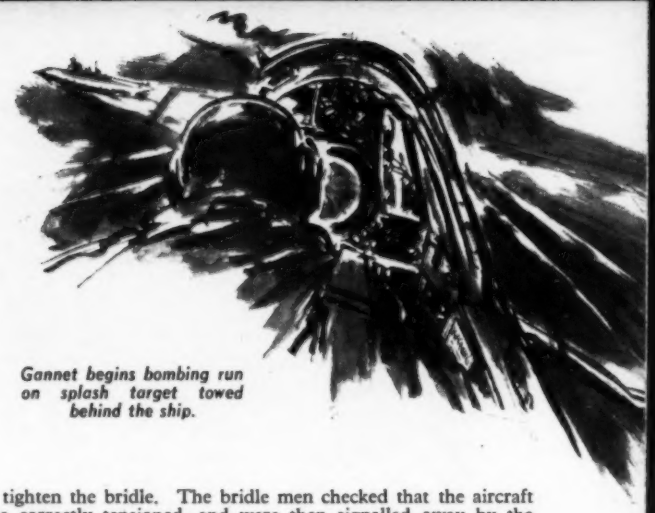
As an indication to Flyco of the endurance remaining when aircraft are returning from sorties, fuel-state R/T calls are used. The fuel amounts corresponding to each of the various calls were checked by the operations officer during his briefing.

"Aircrew man aircraft." The call burbled out from the corner speaker, and we made our way on deck and across to where the four Venoms were spotted, diagonally raked on the port side. Installed in the cockpit, firmly connected to parachute, dinghy, and aircraft, and with oxygen supply checked, I watched as engines were started and the Hawks ahead of us launched.

Once our own chocks had been removed, our machine, too, was part of the precise, well-drilled pattern of flight-deck motion, a pattern that swung along inexorably, with no place for wasted time or indecision. Out from the deck edge, wings unfolded, along to the next director. A pause as the machine ahead was catapulted, then a half-right turn as we taxied toward the starboard booster, and lined up again. The director who was guiding us straddled the low cloud of steam wisping up from the groove.

Forward slowly, a bump as the nosewheel rides over the shuttle, a slight jostle sideways as the mainwheels meet the centralizing rollers, and forward again to the tilted metal flaps that are the loading chocks. Here the rear holdback strop was fixed in position by members of the catapult party. When this was done, the chief E.R.A. in charge signalled to the controllers in the deck-edge howdah, the loading chocks were lowered, and we moved slowly forward towards the safety chocks.

Next the main bridle was looped over the launching shuttle and attached to the catapult lugs on the aircraft. A further signal from the engineer in charge, and the howdah operator applied tension

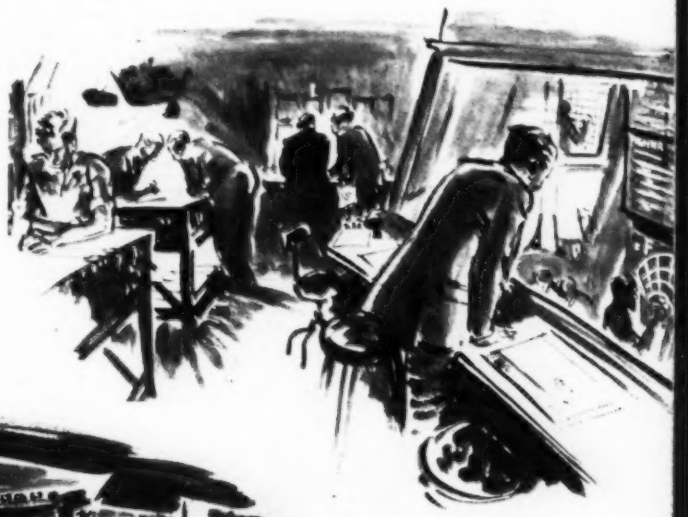


Gannet begins bombing run on splash target towed behind the ship.

to tighten the bridle. The bridle men checked that the aircraft was correctly tensioned, and were then signalled away by the chief, who gave "thumbs up" to the flight-deck officer who was waiting to speed us on our way. He carried a green flag and a red flag, and trailed a long intercom lead from his helmet to a point on the deck.

Before taking over, he pointed to a green-helmeted figure a few feet away who was holding up a board with the words COCKPIT CHECK. OFF BRAKES. The pilot having complied and acknowledged, the board was lowered and the F.D.O. resumed control, winding-up the green flag round above his head as a signal for the pilot to increase power. With the final ready-light now showing at the howdah position, the pilot reached take-off power, raised his left hand and, when he was ready for the launch, dropped it down again on to the throttle. The safety chocks clanged down, the F.D.O. cut his flag smartly down and across, there was a brief pause, and the catapult fired.

It was a new experience for me—to put it mildly—to be accelerated to 115 kt in about the same number of feet. What began as a gradual roller-coaster type of acceleration swiftly



Above, the Ops room. Patrols and searches are handled here.

Left, the A.D.R.—its task, directing fighter defence of the Fleet.

"Flyco, we're altering course slightly—but carry on launching." View from the bridge, with Capt. F. H. E. Hopkins, Chief Yeoman Reeves, Leading Signalman Ferguson and Midshipman Farrow.

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developed into a rather frightening g-cramp which locked me firmly back in my seat (my bone-domed head had been back against the head-rest since before the booster fired, of course, and there was no discomfort there). Time appeared to have slowed down, for several seconds seemed to elapse before the big push ended, suddenly, and we were out over the sea, and flying. Incongruous as the comparison may appear, the feeling immediately after leaving the deck had been just like that after releasing from a winch-launch in a sailplane.

Later, from 20,000ft, we could see the coastal mountains of Spain to the north and those of North Africa to the south. The sun glinted steel-blue on sea and mountain-slopes, with touches of mist in the valleys and snow on the peaks. The phrase "High in the sunlit silence" came to mind.

Interceptions over, we returned to the ship for what was to be my second arrested landing, this time at a higher approach speed and (for me) with a better view of the circuit and the final approach. From the time we picked up the mirror light to the deck-arrival impact (the "crunch" mentioned in Cdr. Goodhart's article is undoubtedly equivalent to the "bam!" scribbled in my notebook), my main impression was the smooth continuity of the pattern. In spite of the obvious and great advantages of the angled deck and mirror sight, however, it was still the pilot who fitted the aircraft into this system, looking after the time element and adding precision in flying. Approach speed before and over the round-down, for instance, was important—these Venoms did not have audio speed presentation, and normal practice was for the observer to call out the speed to the pilot on the final leg. The deceleration after we had landed was firm, but not uncomfortable.

Commenting later on the steam-powered push to squadron pilots, I was assured that (a) one got used to it, and (b) it was a more comfortable boost than the kick from the old-type hydro-pneumatic catapult.

* * *

As the afternoon swung by in its regular, repeated routine, I watched the flight deck and its activity from three different viewpoints. On the deck itself there was bustle, drill, and wind. During launching and recovering there was just no room for unnecessary actions. Aircraft were guided out from the range, passed from director to director, and launched. Between the catapults huddled a group of blue-helmeted aircraft handlers. If all went well they were merely in a very noisy place. If a snag on aircraft or catapult occurred, however, they provided the brute force which was still needed to move aircraft quickly and so avoid delays which could be dangerous, not merely inconvenient.

The flight-deck personnel were identified by the colour-coding of their helmets. Blue, as mentioned, for the general-duty aircraft handlers, including chock-men, catapult party, emergency party and drivers of the ubiquitious deck tractors; red, the fire parties, manning the fire-points during each land-on (plus, of course, the bizarre asbestos-suited fire/rescue men, on hand with their phenomenally effective dry-powder extinguishers). Green identified the special-duties men, such as hook-men, and talkers and tellers at the mirror control position, and the "cockpit check" boardholder. White denoted squadron personnel (squadron number and trade specialization also indicated on helmet); and black-and-white striped helmets distinguished the flight-deck engineer ratings, such as those in the catapult and fuelling parties. White overalls were worn by specialist officers such as air engineers, flight-deck engineers, gunnery officers and mirror controllers.

There was colour, too, in the aircraft, from the glaring, wasp-like stripes of 804's Hawks and 893's Venoms, lately engaged at Suez, to the midnight blue of the burly Skyraiders. There was also noise, or rather a miscellany of different noises. At one end of the scale was the bursting roar of take-off power; at the other the repeated whistle blown before an aircraft lift was moved up or down. Somewhere in the middle of the scale was the cheerful, practised invective emphatically bouncing the walls of the aircraft handlers' ready room.

From Flyco, the sweep of the deck below spreads past. Right aft are the Gannets; right forward a Venom just leaving the catapult, its strop falling away beneath the bows. Little F keeps an eye on all activity on the deck—an eye that ranges wide and fast, for snap decisions have to be made. The object of this movement, this flow, this teamwork on the deck? A launching interval of 30 sec per catapult, and a steady land-on interval of 25 sec. While from deck level the scene was of an immediate concentration of effort, from Flyco the deck-long plan can be seen, more effectively, as a whole operation.

But only from the planeguard helicopter is the complete pattern seen. Keeping station on the port beam, the bearded pilot looks at neither instruments nor horizon, only the deck of his carrier. Now he watches each launch, for on him may depend a pilot's life. And, on the deck, he sees the slow-movement ballet that is the end-product of the flight-deck drill. A graceful, purposeful pattern of aircraft continually changing on the flight-deck stage.

Before take-off on this duty, the Whirlwind's altimeter indicates 60ft—puzzling at first, at least to an outsider not accustomed to flying from a platform at this height above what is literally sea-level. The pilot takes up station some 80ft above the water. After each aircraft is positioned on the catapult the noise of its take-off power building up floats through to him, above the noise of the chopper. Looking across at the island, he sees the faces peering back from the crowded windows of the navigating bridge, and the windswept, off-duty spectators ("goofers" in the vernacular) on the platform above. No matter how familiar the sight, no matter how tired the goofer, there is always a full house up on the island, for they believe that carrier flying is worth watching, and they are right.

Launches completed, the helicopter tilts round in a breezy orbit before taking up position for the landing-on. The returning aeroplanes fly a left-hand circuit, and so the chopper now sits to starboard of the ship, and some distance aft of her—whence the pilot can watch the landings. Thanks to the mirror sight (the ship has two, but the port-side one is normally used), there is little variation in angles of final approach. From the helicopter, distance softens the impact as the aircraft hit the deck. The occasional "bolter" goes round again; but, with the angle, he has a straight run and little bother is caused.

After the land-on had been completed and the aircraft ranged, the helicopter came round and in to its own non-mirror, non-

Rest (but no breather) for Naval Airman Clarke. Scene, the aircraft handlers' ready room.

"Only from the planeguard helicopter is the complete pattern seen . . ." Lt. "Lofty" Myres—and artist Horner's pencil and sketch-pad — in the Whirlwind.

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angled approach and landing. The planeguard crews had yet to rescue anyone in earnest (they touched wood as they answered my question) but, from conversations later with the squadron pilots, I was left in no doubt as to the insurance value of the chopper's presence. The pilots talked the same way of the crash-rescue and fire parties.

In such a complex piece of airfield-cum-hangars-cum-very-large-ship as *Ark*, it was no small problem merely to find one's way about from one place to another—even for an experienced sea-dog with some pretty hazardous trips on the Gosport ferry behind him. But the Navy had thought of that one, and had numbered the deck levels (1, 2, 3, etc. from the flight-deck down) and had lettered the compartments along the length of the ship (A, B, C, etc. from the bows aft). Rather similar, in fact, to the old schooldays game of "battleships"—if the Fleet Air Arm will excuse the word. All one needed to know, then, were the grid references of where one was, and where one wanted to be. But it could still, on occasion, be rather tricky.

One most interesting aspect of the carrier's organization was the relationship between the various groups who lived and worked in her. Although not the most senior officer aboard, the Captain was in command of his ship and all her operations. Under him, an executive Commander was concerned with the ship as a ship, while Commander (Air) headed the Air Department, which looked after the flying operations. In addition, certain specialists (such as the Direction Officer and the Meteorological Officer), although working closely with the Air Department, had a responsibility to the Captain for their duties. The Captain, himself a pilot and observer, had a wide experience of Naval flying and had come to *Ark* from the chair of the Director of Naval Air Warfare at the Admiralty.

The ship's "lodger unit," so to speak, comprised Flag Officer Aircraft Carriers and his staff, for *Ark* at that time was serving as his flagship. The Admiral, a large man (6ft 5in and heavily built) with a large responsibility, is in charge of all the Fleet's operational carriers, and would normally direct their joint operations or exercises from the operations room of his flagship. He himself had carried the unenviable weight of responsibility as commander of the joint Anglo-French Carrier Group during the Suez campaign.

The long arm that delivers the carrier's punch comprised the squadrons, their aircraft and pilots. Their task it was to carry and deliver the bombs, rocket projectiles, cannon shells, and depth-charges; to fly combat air patrols; to keep a long-sighted radar-eye open for attacking aircraft, ships and submarines; and, together with the calm, controlling voice from the ship's A.D.R., to intercept and destroy—to wipe from the spider-web Perspex the red-chalked arrows pointed towards the centre.

Sea Hawks were the shapely day-fighter mounts of squadrons 804 and 898, the aircraft's reputed attractions as a pilot's machine unreservedly confirmed by the pilots themselves. Tigers' heads and flying fish formed their respective squadron insignia; laconic references to "pussy-cats" and "fish-heads" were from time to time exchanged. Their work was ably complemented by the Sea Venom all-weather squadron aboard, No. 893, one of whose pilots was to make the 1,000th aircraft landing on board the following day.

Lumbering bruisers in the fighter world, Wyverns had proved their ability to strike hard—to the surprise of some—in the Suez campaign. *Ark's* Wyvern squadron, No. 831, had not been at Suez but possessed a firm affection for these massive turboprop single-seaters. Cartoon character Flook made an incongruous cowling-badge.

Gentlemen's aircraft from the start, the Gannets of 815 had come from the green hills of Northern Ireland to embark at the beginning of the year. Anti-submarine work was their unglamorous rôle; one of them, however, was to carry the Duke of Edinburgh later that week.

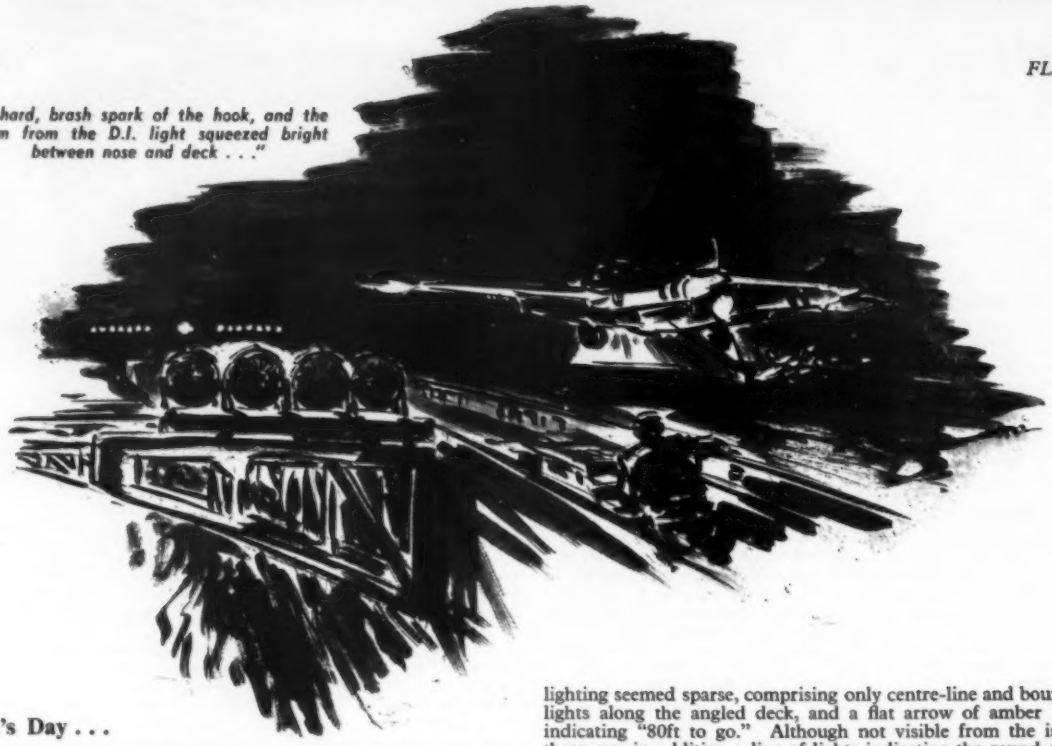
The remaining aircraft were the big, pregnant Skyraiders of 849 "B" Flight, whose landing approaches were always good to watch, if only for the casual swinging from side to side of their striped and spindly hooks. Attached to 849 "B" was an R.A.F. pilot, previously on Shackletons, who did his best to keep up with the high-living standards of his squadron colleagues.

All squadron commanders, together with the other specialist heads belonging to and working with the Air Department, assembled regularly once each day at Commander (Air)'s meeting. Normally this would be held after the end of the day's flying; if night-flying were scheduled, it might take the form of a number of informal discussions during the evening, as convenient. Today, it was to be held in the slight breathing-interval between the end of day flying and the start of night flying.

"Today was pretty good value," Commander (Air) began, looking round the large table at his colleagues, "So far the flying programme has gone very well . . ." The meeting was taking place in the Information and Intelligence Room below the ward-room; the atmosphere was almost that of a city company's Board meeting. The general object was to discuss the day's flying, and to talk about the next day's programme.

"Wings" beamed his genial smile, and the talk got under way. Although two of the squadron commanders had round, West-End faces fit for any Board of directors, the general appearance of those present dispelled my Boardroom fantasy. Some wore "mess undress" in preparation for supper, their black bow-ties contrasting neatly with the yellow scarf of one of the flight-deck

Portrait of a pilot: Lt. Cdr. David Crofts, senior pilot of 804 Squadron (Sea Hawks).



"A hard, brash spark of the hook, and the beam from the D.I. light squeezed bright between nose and deck . . ."

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officers who had come straight from the deck. A couple of goon-skins, some battledress suits, and the majority in ordinary uniform. One or two older, practical men's faces and a few on the youthful side contrasted with the majority—an average-looking sample of men.

There were present Ops, Direction Officer, Little F, squadron C.Os, A.E.O., A.L.O., F.D.O., A.C.R.O., F.D.E.O., H.C.O. M.C.O., gunnery officer, T.A.S. officer and others—in all, a hefty collection of initials. A lot of people are involved when you start flying aeroplanes from carriers.

After an early supper that evening, I was one of six unfortunates selected to appear in a programme on the ship's own closed-circuit television network. Reluctantly leaving Lofty, the bearded C.O. of the ship's helicopter flight, to continue discussing vintage cars over coffee, we were taken away by our round and amiable inquisitor, the ship's bosun, *via* mess-decks, pitch-black weather decks and murderous, steel companionways to the small closet that was the studio. The title of our epic programme was *Justify Your Existence.*

The entertainment was obviously planned to a tight time-schedule, for we had arrived while an earlier programme was still running. "Don't forget," a bald lieutenant-commander was saying, as he waved a piece of metal vigorously at the camera, "ejectors are important." We crawled on hands and knees across the room, between camera and subject. "Remember!"—the sharp call stopped us in mid-crawl—"your ejectors. They are *very* important." The certainty that this expert could easily justify *his* existence was unaffected by the fact that I had not the faintest idea what he was talking about.

Our programme was intended to introduce to the ship some of the strange people (the bosun gave an unusual intonation to the word "strange") on board *Ark.* The others comprised a commander of the Admiral's staff ("Certainly I deny we do nothing. Neither do we occupy the best accommodation"); a major in the Carrier-Borne Ground Liaison Section; an R.A.S.C. private in the C.B.G.L. unit ("Honestly, no, I don't really believe in hammocks"); an R.N.R. officer carrying out his twelve-month period with the Fleet; and the moustached ex-Shackleton pilot on exchange posting with 849 "B" ("Then they said 'night deck-landings'—and they actually meant it!")

Escaping with relief, we sought out the wardroom bar to quieten our nerves before going up to watch the night flying. Our genial liaison officer, Ops 3, had previously spoken enthusiastically about the wonders of *Ark's* television, but then *he* had interviewed Miss Simone Silva on *his* programme, which was rather a different matter.

* * *

We watched the flying that night from Flyco. There was a full moon, shining on a calm grey sea which, nearer the ship, changed to a choppy, dark blue. Against the windows of Flyco and the bridge blustered a noisy wind. Directly ahead of the ship were the lights of *Apollo,* the fast minelayer which had taken over as planeguard for the night.

Shadowy figures moved across the dark flight-deck. The deck-lighting seemed sparse, comprising only centre-line and boundary lights along the angled deck, and a flat arrow of amber lights indicating "80ft to go." Although not visible from the island, there was in addition a line of lights indicating the round-down. Immediately below us were five hooded Hawks—wings folded, protective covers over canopies, securely picketed in the shadow of the island.

The sequence followed that during the day. "Aircrew man aircraft" . . . "Man the range" . . . "Stand clear of propellers and jet-pipes." Flyco's red traffic-light on, and the start-up signal—pilots and flight-deck officer now communicating by means of the aircraft's downward-identification light and an amber wand. Navigation lights flashed; amber traffic-light on; and the Venoms taxi forward, following the sure, smooth movements of the directors' wands.

Flyco's traffic-light turns to green, the signal to begin launching. The flight-deck officer at the catapults circles a green wand above his head—not that we see him, only the circling green pencil—and in the grey darkness there is take-off power. The aircraft's navigation lights flash on, signalling that the pilot is ready. The green wand cuts down like a cathode-ray trace, and the launches have begun.

After the Venoms have disappeared for their night interceptions, three Gannets take off to practice touch-and-go landings. Only one of the mirror-sight source lights is switched on—an ample intensity for night conditions. The squadron C.O. watches from Flyco, too, commenting by R/T to the pilot after each landing ("Nine seven—too fast and to port"). Three red lights, the outer ones moving up and down slowly in relation to the centre one, are seen in the port catwalk near the mirror, giving the Flyco watchers an indication of each machine's final approach. The night batsman still has a useful function, but he is now looking at the nav. lights in the mirror, and his signals are information for Flyco, not guidance for pilots.

In the subdued lighting of the bridge and Flyco, the occupants wait, watch, and carry out their unobtrusive duties. Two midshipmen keep the log of aircraft movements and answer voice-tubes and telephones. Little F's bearded operator keeps an R/T listening watch. Commander (Air) watches also, as does the Captain. Near the Captain stands his capable, experienced Chief Yeoman—and all the other skilled men whose job it is to look after the ship side of things.

Most dramatic of the night landings are those of the Venoms. Navigation lights tilt on to an unseen final leg—a slow, gradual approach, it seems. The lights come steadily nearer, and finally appear to accelerate and rush down towards the deck, the moment of arrival marked with a hard, brash spark of the hook and the beam from the D.I. light squeezed bright between nose and deck.

Between each land-on, small deck-level floodlights alongside the arrester wires were switched on, enabling the re-setting of wires to be checked. Day or night, six wires were used, the mirror sight set up so that a perfectly flown approach would end with the hook engaged in No. 2 wire. The angle and height of the mirror were adjusted for the particular aircraft type.

Night flying continued on an hourly cycle. At 2220 two Venoms were launched and two recovered. At 2320 two were recovered, and the day's flying programme was ended. Lights

from the island were switched on to illuminate the deck, Venoms and Gannets disappeared below on the side and rear lifts, and Little F called "Flying for the day is completed. Secure flight deck." Switching off his microphone and putting it down, he turned from Flyco. "Now for some bacon and eggs. Let's shut up shop."

Meanwhile, the Chief Yeoman was passing a signal from the Captain to *Apollo*, now sheering off into the darkness, her plane-guard duty completed. " . . . must have been very boring for you but it was good value for us . . ." Earlier, the duty signals officer had smiled on receiving the reply to another signal from *Ark*. This original signal had been addressed to *Tidereach*, the tanker from which *Ark Royal* was refuelled during that week, and had read: "I should like to use you as a target for air search and dummy attacks while on passage. Request you report at 1800 daily your estimated position at 0800 next day."

The reply from *Tidereach*, agreeable but somehow not quite at ease, had been: "Certainly we should like to co-operate but please ask your aircraft not to make any mistakes."

Ark's day was not ended, even now. Between the great, dark lift-wells, their walls embroidered with a hanging pattern of catapult strops, the bright-lit hangars were still busy. Throughout the day they had been busy, with a continuous contact with the A.C.R.—the Air Department's information centre on aircraft availability. Air engineer and electrical officers, hangar control officers, workshop artificers, air mechanics, safety-equipment ratings, and innumerable others; planning, changing, maintaining and repairing to meet the day's flying programme.

When the aircraft needed for *tomorrow's* programme had been checked—and worked on, if necessary—the hangars could become still. The Air Maintenance Control Room (the main centre for maintenance records), however, was one of the ship's many departments which were staffed 24 hours a day.

The phrase "tomorrow's flying programme" had itself implied many hours' work, too. Within the broad framework of the Air Department's task for the week, Ops had begun to write this detailed daily programme (involving aircraft types and numbers, squadrons, exercises to be flown, and timing) at about three o'clock that afternoon. Checked by departmental heads concerned and by Commander (Air)—and signed by Ops and Little F—the programme was then ready to be discussed at the Air Department meeting and used as a basis for the more detailed programmes drafted by the individual squadrons.

Many others, obviously, had geared a full day's effort to the operating cycle of the ship. On the armaments side, however, there still remained a particularly heavy load at the beginning and at the end of the day. Rockets and bombs to be loaded in the bowels of the ship on to the special lifts, raised, and stored in the ready-use compartments; cannon ammunition to be brought up and stored also. This week of intensive weapons flying meant a particularly heavy effort for the ammunition parties.

All this effort, combining to effect the single-minded completion of an aviation task, was superimposed on the normal day-to-day working of a large and complex ship. Teamwork, again, on the grand scale—even if the agonized noises which came during the evening from band-room 2W8 did indicate a lack of harmony in at least one part of the ship. It all added up to a typical day at sea.

* * *

During the week which followed, the carrier slipped well into her planned routine. The operating cycle became smoother, with drill and repetition a dozen times a day. Certainly there were unplanned incidents—the firing mechanism of the port catapult caused trouble, a delay in fuelling caused aircraft to be taken down unfuelled to the hangar so that an incoming sortie could land on, an underwing tank burst and caused some hectic squeegee-ing of the deck, and a Venom wing-tip caught the mirror reference-lights as the machine made a night landing on the left of the centre-line. These incidents only emphasized the high standards demanded of those who choose to associate with Naval aviation.

The week had its high-spots, too, the most welcome of which was an informal visit to the ship by the Duke of Edinburgh. He cut a celebration cake to mark the 1,000th landing by an aircraft on board.

By Saturday, the week's programme had been completed and the ship lay at anchor off Gibraltar. Across the bay lay Algeciras, low and white, with hills rising behind the town. On the after end of the flight deck, the mobile crane was assisting in the engine-change of Wyvern 386. Just in front of the island was a worn-looking London taxi which, normally resident in the helicopters' hangar-level bay, had come up for some week-end air. Its joint owners were the ship's commanders—or sergeants, as the noble three-stripers were known.

That evening, an Air Department meeting—of a kind—would probably be held at *La Venta*, Gibraltar, where sundry members of the Admiral's staff, squadron aircrew from *Ark* and *Albion* (also at Gib.) and other Naval officers would, co-incidentally, be having themselves a big time, too. But now, in the afternoon, and here on the flight deck, it was quiet. On the side of the island, the Battle-honours board, clear in the sunlight, gave a link with History. "Armada, 1588" it began.

* * *

But that was the week ahead. We had just ended the first day of that week, and we were pretty tired. But carrier flying is a tiring business. It is also the most fascinating and exacting business in aviation.

At 0700 the next morning, in accordance with Daily Orders, the aircraft ammunition supply teams of the first part of the Port Watch, together with Nos. 2 and 3 bomb-lift crews, mustered outside X Gun-bay. Fifteen minutes later, "flying stations" was sounded off.

Ark's day had begun again.

DEVELOPMENT OF THE AIRCRAFT CARRIER (continued from page 382)

aft; the designer therefore has a simple exchange rate between aircraft launching speed and catapult strength. A strong aircraft can be launched to a high launching speed, thus reducing the necessity for high-lift devices or enabling increased launching weight to be accepted; but this catapulting strength costs extra weight anyway, so the circle is vicious. All this assumes that the catapult maximum power will be sufficient, but this can be arranged more easily than lengthening the catapult.

Deck Operations. Conditions on a carrier deck can be pretty rugged, but aircraft must be operated just the same. The time-honoured method of moving aircraft was by manpower, or under their own power during launching and landing operations; but this is fast becoming impractical with the large aircraft weights now appearing, and mechanical handling is being developed. The requirements are quite severe, as the instantaneous gradient on the deck may well be 1 in 10 when the ship is rolling and particularly during turns. The space available is extremely cramped and necessitates a mechanical handler of extreme manœuvrability. The handler must also have the ability to attach and detach itself quickly and easily to and from the aircraft.

An important item in deck operation is the amount of assorted equipment which has to be brought up for servicing and other purposes. Oxygen trolleys, arming trolleys, starting trolleys, chocks, intake guards, fuel hoses, air hoses, electric power leads —all these items, and more, may be required. Apart from the space they occupy even when stowed they certainly do not simplify the general congestion on deck; in calm and easy conditions they may not be troublesome, but with bad weather thrown in they can be a menace. Some of these items are inevitable, but starting trolleys at least should not be necessary, for some of the modern inbuilt starting systems produce the required result with only a small addition to aircraft weight.

Another major item of equipment is the mobile crane, which is essential for clearing the deck in the event of an accident; with aircraft weights going up fast this is becoming a chunky piece of machinery, and again it buys up valuable deck space.

Little things like the type of paint on the deck can be extremely important. Rubber tyres on a wet steel deck behave much like skis on snow; there is nothing more discouraging than seeing an aircraft, wheels locked, sliding towards the edge of the deck.

The vast amount of fuel required by jet aircraft has produced a complete change in ship's aircraft fuel systems. Very fortunately a jet fuel (Avcat) has been developed which can be stowed in ships' tanks in the same way as the ship's boiler fuel. Petrol, on the other hand, has to be stowed in special "tanks within tanks" for safety. Use of Avcat enormously increases the aviation fuel stowage capacity of the carrier and at the same time has simplified the fuel system to a considerable extent. The new fuel systems have to be capable of high pumping rates to keep down the turn-round time.

Conclusion. The carrier has advanced immeasurably in the last ten years and has now reached the stage where there are but comparatively minor problems in the operation of aircraft. Mere operation is, of course, valueless unless the aircraft are capable of effective operations against the enemy; present-day effectiveness is limited to conventional explosives and inevitably the offensive power of a carrier is limited by the size and number of aircraft it carries. The day is not far distant when nuclear weapons will confer on the aircraft carrier an enormous potential while at the same time its mobility gives it a relative invulnerability, as compared with fixed bases, to the ballistic-missile type of weapon.

In the United States it is already realized that the aircraft carrier forces form a valuable part of the overall defence effort. We in this country must also realize the even greater importance to us of the aircraft carrier.

A Sea Venom is launched from "Eagle's" port catapult during the operation.

Operation "Musketeer"

A Carrier Force in Action: the Fleet Air Arm's Part in the Suez Operations

VIEWED as a "local war" exercise in the operation of carrier-based aircraft against ground targets, the Suez campaign gave an effective demonstration of a carrier group's mobility and strength. Over 1,600 sorties were flown by the Sea Hawks, Sea Venoms, Skyraiders and Wyverns of *Eagle, Albion* and *Bulwark,* in addition to the helicopter troop-carrying and casualty-evacuation operations from *Ocean* and *Theseus.*

For the Franco-British Carrier Group, commanded by Vice-Admiral Power, there was a three-fold task: to neutralize the Egyptian Air Force; to destroy other important ground targets; and to support the troop assault on Port Said and Port Fouad. These three phases occupied six days' flying.

Airfields attacked included Cairo West, Cairo Almaza, Inchas, Dekheila, Bilbeis and Gamil. On the second and third days the major effort was switched to other targets, which included Gamil bridge—a "tough nut" finally destroyed in dive bombing by Sea Hawks—and tank concentrations. During this period a Wyvern pilot from *Eagle* was forced to ditch his aircraft in the sea only two miles from Port Said (and 70 miles from the ship), but was rescued by the ship's helicopter.

Following the parachute drop of troops on the fifth day and the seaborne invasion on the sixth, close air-support for the ground troops was the carrier aircraft's task. This was mainly effected by "Cabrank" patrols over Port Said and Port Fouad, from which aircraft were called down to attack specific targets on the R/T instructions of Army air-control teams who had landed with the first parachute drop. In addition, regular combat air patrols were flown as a defensive precaution. Another example of rescue by helicopter occurred when a Sea Hawk was shot down by anti-aircraft fire during an attack on El Quantara. The pilot ejected, landed on the east side of the Canal and was guarded by C.A.P. aircraft (which dissuaded two vehicles from approaching) until *Eagle's* helicopter arrived with fighter escort.

Following the parachute operations and that day's air activity, Admiral Power received from the Army commander ashore the following message: "To all supporting aircraft. Many thanks for your magnificent support to us this day which thrilled all ranks. Its timely effectiveness and accuracy were beyond praise and doubtless saved many casualties. . ."

The effectiveness of the carrier-borne attack (*Flight* learns from interviews with those who directed and who took part in the operation) was due essentially to a combination of three factors. These were the short range from ship to target (giving a long time over target), the quick aircraft turn-rounds, and the fact that, with three carriers flying a staggered operating cycle, it was possible to apply a *continuous* pressure—as opposed to the periodic peak efforts of the long-range R.A.F. aircraft. Conditions were eased, clearly, with the absence of enemy air and submarine attack. (An extra, incidental ability displayed by aircraft from *Eagle* was to supply water, medical supplies and a thousand cans of beer to the parachute troops at Gamil airfield.)

Meanwhile, *Ocean* and *Theseus,* under the command of Rear-Admiral G. B. Sayer (normally Flag Officer Training Squadron, acting on this occasion as Flag Officer Helicopter Group), were operating as helicopter assault carriers. They carried the eight Whirlwind HAS 22s and two Whirlwind HAR 3s of 845 squadron, R.N.; and six Whirlwind HAR 2s and six Sycamore 14s of the Joint Helicopter Unit from R.A.F. Middle Wallop.

As is well known, these machines were used to land troops of No. 45 R.M. Commando, together with stores, at Port Said on November 6. Other work carried out by the helicopters included casualty evacuation and many other tasks.

Gamil bridge under attack: a miss which damaged the nearby radar station. The bridge was subsequently destroyed.

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns; the names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

Expanding the Mass-travel Market

I READ with great interest the comments on page 257 of your issue of February 22 regarding Viscounts, colonial-coach-class services and so on—and appreciate the sympathetic and practical attitude you adopt towards this problem.

There is, however, one point over which I would like to take issue with you—and that is the implication that even before we ordered the Viscounts we knew they would not be allowed on the colonial-coach services.

This is far from being the case. We knew that there would be objection from certain quarters to their use, but in our view the mere fact that we were developing a new class of traffic (even though the Corporations at that time did not recognize that a potential new class of traffic existed) and had to operate at lower fares meant that we would be encouraged, not banned, from using appropriate, more economic types of aircraft as the justification for colonial-coach services was progressively proved.

It was also obvious that, as time went on, more stringent operational restrictions would be applied to obsolescing types, and we assumed this would make it even more logical and essential for more modern types to be used. We were also certain that the third-class conception would spread throughout the world, and that when it did so the established operators would be pressing for the use of *modern* types, not the *oldest* types, on this category of service—i.e., the most economic modern type available at the time.

Our attitude on this was, as we saw it, confirmed by the Government's declared intention of opening up *long-term* opportunities to the Independents of which the colonial-coach services were one of the major opportunities; and we took it for granted that no government would on the one hand try to emphasize the worth of such new opportunities and on the other hand stop their development.

The coach-class conditions which you quote in your article are only exemplary and not specific. This is quite clearly shown by the use of the abbreviations "e.g." at the beginning of the appropriate paragraph and "i.e." at the end of it. In other words, these were merely examples of some of the various conditions which could help to qualify a service as colonial-coach class. There is no statement at all that the type of aircraft has to be in itself inferior, or of some particular shape, size or motive power. Obviously, such a specific statement could not be made, because some routes, to be economically possible and commercially saleable, would need a different type of aircraft from other routes. In our view the Viscount has always been the ideal aircraft for developing this new category of traffic at lower standards on the African routes, by offering a night stopping service with considerably less comfort, speed, catering facilities and so on. It is the type of service which probably would not interest more than 10, 15, or perhaps 20 per cent of the travelling public; but if that percentage wants that type of service and it helps generate new traffic, why not let the public have it?

I think the tremendous expansion of the African routes since we started our colonial-coach service shows exactly how new experiments and new facilities help to develop traffic to everyone's advantage.

London Airport. M. H. CURTIS,
Managing Director, Hunting-Clan Air Transport, Ltd.

A.W. Ensign History

AS a former member of Imperial Airways/B.O.A.C.'s staff for a number of years, may I express my appreciation of your publishing Peter W. Moss's fine history of the A.W.27 Ensign-class transports. Obviously the author has spared no effort in the vast amount of careful and painstaking research. He has indeed recorded so much little-known information on this aeroplane, particularly its career in World War II.

I feel sure Mr. Moss will have no objection if I add a few additional points. For example, although D.H. three-bladed two-speed controllable-pitch propellers were fitted on the prototype G-ADSR when she made her first flight on 24.1.38, the original Imperial Airways specification dated 22.9.34 did not include C.P. propellers. Instead, *four-bladed fixed-pitch metal propellers* were considered to be "good enough" by Imperial Airways! I have a cutting taken from a 1938 issue of *Popular Aviation* magazine which shows a three-view detail drawing of the Ensign prototype fitted with these four-bladed props. Presumably both Armstrong-Whitworth and Imperial Airways were later convinced of the suitability of the highly successful Hamilton c.p. props (which had thoroughly proven themselves on the Boeing 247 and the DC-2/DC-3 series from 1934 onwards) and—with the Hamilton licence shortly afterwards purchased by de Havillands—it would have been sheer "pig-headedness" not to have chosen them.

Regarding the decision to fit Wright Cyclones in place of A.S. Tiger 9Cs, I feel fairly certain this decision was originally made by the Board of Imperial Airways during Sir John Reith's short chairmanship (1938-9). Did not Imperial Airways send a technical mission to the U.S.A. early in 1939, headed (I believe) by Mr. A. C. Campbell-Orde, when the decision was made to purchase a large quantity of Wright Cyclones with the view to fitting them to *all* the Ensign fleet? The outbreak of war completely upset this plan, and, as Mr. Moss reports, it was not until late 1940 that the first Ensign Mk II G-AFZU (ex-G-ADTD) had modifications started, and was not test-flown until 24.6.41 (with the Wright Cyclones).

In conclusion, like the famous old Whitley bomber, the Ensign had the same "nose-down in level flight" characteristic—which perhaps stems from the fact that both types originated from the same design team, headed by A.W.A.'s chief designer, Mr. J. Lloyd.

Nairobi, Kenya. DENNIS M. POWELL.

Prophets Unstuck

DEBUNKING aviation's Isaiahs is an entertaining game which Mr. A. V. Cleaver plays with zest and skill, whetting one's appetite for the concluding instalment of his *Prophecy in Aeronautics* article.

Meanwhile, it may not be inappropriate to quote from a French book called *Wonderful Balloon Ascents; or, The Conquest of the Skies*, by F. Marion, published about 1870. The author boldly calls his first chapter "The conquest of the skies," though confessing this "may appear ambitious . . . to those who know that the infinite space we call the heavens is for ever inaccessible to travellers from the earth"; and later, reviewing attempts to fly, he avers that these were "conducted on a wrong principle, the machinery employed being heavier than the air itself."

Mr. Cleaver, no doubt, wholeheartedly endorses that verse from Hymns A. and M.:—

"Prophecy will fade away,
Melting in the light of day."

London, S.W.1. A. SMITH.

"Below Squadron Status"

WE were pleased to be mentioned in your issue of March 1—"Below Squadron Status (Part 2)," by R. C. Sturtivant—but I should like to point out a mistake which, though not of national importance, is important to the flight.

After leaving Korea in 1955, 1903 Flight returned to England and joined 657 Squadron (later to become 651 Sqn.). We became independent again for the Suez operation and, having spent a bare five weeks around the Middle East, returned again to England.

R.A.F. Feltwell, Norfolk. R. E. PINK, Capt.

FORTHCOMING EVENTS

Mar.	26.	R.Ae.S.: Main Lecture at Reading: "Present and Future Developments in Civil Aviation," by P. G. Masefield, M.A. (Eng.), F.R.Ae.S.
Mar.	27.	Royal Society of Arts: "London Airport," by Sir Alfred Le Maitre, K.B.E., C.B., M.C.
Mar.	30.	Air-Britain: Annual General Meeting.
Apr.	1-6.	Southampton University: Course on Aircraft Acoustics.
Apr.	4.	R.Ae.S.: Main Lecture: "Engine-Airframe Integration," by L. F. Nicholson, F.R.Ae.S.
Apr.	5.	Helicopter Association: "Problems Associated with the Strength Assessment of Rotor Blades," by V. A. B. Rogers, D.C.Ae., A.F.R.Ae.S.
Apr.	5.	A.B.A.C.: Annual Dinner.
Apr.	6.	British Interplanetary Society: "History of Rocket Development in the Walterwerke," by H. Walder.
Apr.	9.	Aviation Forum: Annual General Meeting.
Apr.	9.	R.Ae.S.: Section Lecture: "Fail-Safe Structural Design," by N. F. Harpur, Grad.R.Ae.S.
Apr.	16.	R.Ae.S.: Section Lecture: "Simulation Techniques in Aeronautics," by J. J. Foody, Grad.R.Ae.S., and R. A. Paul.
May 24-June 2.		Paris Aero Show, Le Bourget.
Sept.	2-8.	S.B.A.C. Show, Farnborough.

R.Ae.S. Branch Fixtures (to April 23):

Mar. 27, *Leicester*, "Helicopters," by R. Hafner; *Luton*, Annual General Meeting; *Preston*, "Aerial Survey," by B. J. Atwell. Apr. 2, *Boscombe Down*, "High-speed Experimental Test-flying," by Col C. Yeager. Mar. 28, *Bristol*, Annual General Meeting and Film Show; *Isle of Wight*, "Rocket Motors," by S. Allen. Apr. 3, *Luton*, "Measurement of Aircraft Vibration in Flight," by D. A. Drew; *Weybridge*, "Atomic Energy for Aircraft Propulsion," by J. E. B. Perkins.

The last of the R.A.F. Yorks—"Ascalon II"—before leaving Changi, Singapore, for Aldergrove, N.I., where it becomes "surplus to requirements" (see paragraph below). Since going out to the Far East three years ago, "Ascalon II" has flown 300,000 miles.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

Royal Fleet Visit

THREE aircraft carriers, H.M.S. *Ark Royal, Albion* and *Ocean,* will probably be among the 17 or more ships of the Home Fleet visited by the Queen at Cromarty on May 27-29. There is to be a fly-past of Naval aircraft and, according to a provisional programme issued by the Admiralty, Her Majesty may embark in a carrier on the morning of May 29 to witness flying, disembarking to H.M.Y. *Britannia* later that day when her visit to the Home Fleet ends.

R.A.A.F. A.O.C. Malaya

IN Canberra last week the Australian Defence Minister, Sir Philip McBride, announced that A.V-M. V. E. Hancock, R.A.A.F., had been appointed A.O.C. Malaya for two years from 1957. He succeeds A.V-M. W. H. Kyle Syme.

Operation Grapple

FOUR Valiants of No. 49 Sqn., Bomber Command, left R.A.F. Wittering, Northants, last week for Christmas Island in the Pacific, where the first British hydrogen bomb tests—code-named Operation Grapple—are due to take place later this year.

The Valiants, which have been treated with anti-thermal radiation paint to reduce the effects of nuclear flash and have had their cockpit windows shielded to protect the crews from glare, were flying independently to their destination. It has been said—though not officially—that they will drop a bomb from 30,000ft to explode at 10,000ft. A force of Canberras is to fly through the mushroom cloud after the explosion to collect samples of fall-out, and the R.A.F. task force will also include Shackletons, Hastings, Varsities and Whirlwinds.

2nd ATAF Trophy Winners

RESULTS of the two major inter-squadron competitions for R.A.F. units in Germany during 1956 have been assessed by H.Q., 2nd ATAF. The Duncan Trophy, for air gunnery proficiency, has been won by No. 256 Sqn., R.A.F. Ahlhorn, equipped with Meteor N.F.11s and commanded by W/C. R. D. Max. The Sir Philip Sassoon Photographic Reconnaissance Trophy, for the most accurate and economical coverage of a specified target, has been won by No. 541 Sqn., R.A.F. Wunstorf, equipped with Meteor P.R.10s and commanded by S/L. C. W. Clark.

Farewell to the York

LAST of the R.A.F. Avro Yorks, MW295 *Ascalon II* returned a week ago to the United Kingdom from the F.E.A.F. communications squadron at Changi, Singapore, for disposal as surplus to R.A.F. requirements. It was named after the first production model York, LV633, which appeared in 1943 and was called *Ascalon* (the sword with which St. George slew the dragon) at the suggestion of W/C. H. B. Collins, then c.o. of No. 24 Sqn. As a V.V.I.P. aircraft, *Ascalon* flew King George VI, Mr. Winston Churchill and many other wartime passengers.

After the war, LV633 went to the Far East and was eventually replaced by *Ascalon II,* which was taken out to Singapore in 1954 by S/L. Douglas Boards, personal pilot to Air Marshal Sir Francis Fressanges, C-in-C. F.E.A.F. S/L. Boards speaks proudly of *Ascalon II's* reliability; in his three years and 1,600 hours' flying experience of it, the aircraft has only four times been delayed in take-off.

IN BRIEF

The R.A.F. is to depict a day in the 1942 siege of Malta during this year's Royal Tournament, being held at Earl's Court from June 5 to June 22.

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Kenneth More will be the narrator at the second R.A.F. Anniversary Concert, to be given in the Royal Albert Hall on April 13 by the Hallé Orchestra and the R.A.F. Central Band.

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The disbanded No. 603 (City of Edinburgh) Sqn., R.Aux.A.F., now has a permanent public memorial in the form of a Spitfire in wartime camouflage on a cement base outside R.A.F. Turnhouse.

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Air Marshal Sir John McCauley, retiring R.A.A.F. C.A.S., has become Patron of the Odd-Bods (U.K.) Association, membership of which is restricted to R.A.A.F. personnel who served with the Allied Air Forces in the European and Italian theatres of war.

The four Valiants of No. 49 Sqn. at Wittering, Northants, before leaving for Christmas Island (see third item). Below are their co-pilots, from left to right: F/L. D. W. Briggs; F/O. M. A. Pringle; F/L. R. Howard and F/O. R. L. Beeson.